Jerome Wiesner

(McGraw-Hill, 1965) $6.95

of any arms limitation step must be explicitly defensible. The proponent of arms limitations is expected to demonstrate that such a course is indeed better than the all-out arms race alternative. This is very hard to do; in fact, almost impossible to do, because as I have already said, there isn't really any adequate means of assessing the effectiveness of what is already being done.

While nearly everyone believes that the arms race is very dangerous, some of us believe that it's more dangerous than others do. But practically no one believes that we can continue the violent arms race with the intense research and development effort, and the immense build-up of nuclear weapons all over the world, without running a great risk of a nuclear catastrophe occurring within the next decade or two.

Leo Szilard once placed a ten percent per year chance on the probability of a nuclear war occurring. (I don't know where he got that number.) Some people would put it lower and some higher. Even as little as a two or three percent chance per year of having a war in the next decade is too high to accept. Obviously no one can really evaluate the apriori probability of a war; though the risks appear great, they are not quantitatively assessable.

This inability to actually evaluate or agree upon the risks of the arms race makes agreement on the value of arms limitation difficult, for you have to convince people—and usually the people who are antagonistic to any limitations—that such steps are safer than something else which can't be measured.

To overcome this difficulty we must try to create a vested interest in arms control; to develop a cadre of people whose full-time occupation is research and development on means of arms control and on the analysis of the political and military problems of arms control. There have been a number of recommendations to create a full-time substantial arms control staff and one of these should be put into effect. Until this is done, progress is condemned to be very slow.

When I recommend a large arms control staff I may give the impression that the problem is tougher than it really is. We could go a long way with just a little common sense, but we could go further, do it quicker and with much greater confidence if there were a thorough understanding of the myriad of individual prob-

lems involved. We won't be able to judge the total value of such studies until we have had a major effort for some time. A major effort, compared to past efforts, would be twenty people working full-time, though a much bigger operation can easily be justified.

An obvious example of the difference between the kind of effort required to develop a weapon and that required to provide an adequate means of controlling its further development or production is given in the nuclear test ban case. In recent months our lack of understanding of underground seismic phenomena and the lack of a well-understood seismic detection system for underground nuclear tests has been a principal stumbling block in the way of an international agreement to stop nuclear testing. The United States has belatedly begun an intensive development and test program to create the necessary monitoring devices and to get the experimental data to make intelligent discussion possible. It is appropriate to ask why this work was not begun a long time ago. After all, the nuclear test ban has been a possibility for a number of years and was formally explored at the London Disarmament Conference in 1957. Yet, only in 1960 was a study initiated to understand the technical details of the monitoring problem. Why? Probably because sensitive seismic detectors are not needed in the development of nuclear weapons so there was no need to develop them in conjunction with the weapons and there is no government agency responsible for the creation of a disarmament capability.

The experience with the test ban also points up the important fact that it is difficult to evaluate any single disarmament step by itself. There are two principal reasons for attempting to negotiate a nuclear weapon test ban: (1) to prevent radioactive fallout caused by atmospheric explosions, and (2) to carry out a first step arms limitation measure in the hope of building up confidence which would permit further steps to be taken. To eliminate the fallout hazard, only tests in the atmosphere would have to be prohibited, a ban which would be easier to monitor. The total prohibition of nuclear testing would require monitoring for clandestine underground and outerspace tests, a very much harder task if an essentially violation-proof system is desired.

A great deal of judgment is required to balance properly the possibility of clandestine testing, and any dangers therefrom,

against the importance of making a serious start on arms control. Even more important is the fact that with certain arms limitations and control—for example, an adequately monitored agreement prohibiting national ownership of nuclear materials—a test ban monitoring system might be unnecessary. This suggests that some partial disarmament measures may require an extensive inspection system which might be less important in the case of more comprehensive disarmament. This difficulty can only be avoided by having an adequate understanding of the details of arms limitation systems that might be acceptable to the country; an understanding that can only be obtained by intensive study of the problem. In spite of the gaps in our knowledge, we have spent enough time on the various aspects to be reasonably certain that effective systems can be devised. In fact, they can be outlined now. Without considerable further study, however, it will be difficult to convince skeptics of their feasibility. Furthermore, at this stage of our comprehension of the problem, we will probably insist on far more control than would be required if we had a better grasp of it.

I would like to contrast our arms control effort to the ballistic missile design effort, for the nation is in the same uncertain state of mind with regard to the feasibility of arms control as it was regarding the feasibility of missiles in the early 1950s. The Von Neumann Committee, after a detailed study, became convinced that such missiles could be built, in spite of the doubters, who were mighty numerous and died hard, and didn't believe that intercontinental ballistic missiles were practical at all. In the spring of 1953, because of intelligence information, we were certain that the Soviets already had an effective, hard-driving ballistic missile effort and that the United States had to match it. In spite of this, and as late as 1957, a high ranking military officer, still on active duty, told me that I was doing the country a serious disservice by overselling ballistic missiles, and he went on to say that we would not see operational missiles during his "active lifetime." Within a few months after the Von Neumann Committee report we were able to put three or four hundred scientists and engineers to work on the then identifiable problems of the ballistic missile. Not much later there were thirty thousand people working on the program and during the past five years we succeeded in overcoming all of the serious technical

problems that stood in the way of a practical long-range ballistic missile. Our confidence was vindicated. I have the same confidence today regarding the technical and military feasibility of arms limitations. The thing most lacking is the determination and courage to make a serious attempt. I am convinced of this, for we can now demonstrate a probable solution for each of the difficult problems that can be raised, though some of the solutions would not be readily acceptable. Arms control is much more complicated than developing a ballistic missile, yet for some inexplicable reason many people seem to believe that we can understand the intricacies of limitation and disarmament without working on them.

Another thing that has troubled me is that technical reasons are often given, possibly unconsciously, for not entering into arms limitation agreements that we wish to avoid for other reasons. This has been a most serious stumbling block in the past. If the leaders of the United States really understood where they wanted to go in the disarmament field, if the whole government felt as strongly about wanting to do something about arms control as does the President,* and if the Congress were behind the objective, the technical problems would not seem nearly so formidable.

Another really difficult question to answer is the one that Dr. Szilard raised when he talked about the Soviet proposal for complete and general disarmament. The question is this—what kind of a world do we want to live in and do we think we can best survive in? Do we want a totally disarmed world? And if so, are we prepared to cope with the new political situations which would then exist? Much thought and study must be given to these questions as well as to the technical-military problems if we are to move ahead with confidence.

My own view has always been that it would not be sensible to agree to any general disarmament arrangement until there is a satisfactory international security force and an acceptable international legal mechanism to manage it. I believe that the development of an arms control system has to proceed in steps. We should first try to stop the accelerating arms race and to achieve a situation in which there was less tension and fear, one in which we were willing to begin reducing arms and in which the Soviet Union would be

* President Eisenhower.

tail by a number of military writers, is basically quite simple. It is an attempt to curb the arms race by setting up a system in which a surprise attack by one side cannot prevent retaliation by the other and is thus deterred. This is an attempt to follow the course defined by Dr. Leo Szilard as "learning to live with the bomb."* While a system of mutual deterrence is less attractive in many ways than properly safeguarded total disarmament, it may be somewhat easier to achieve and could be regarded as a transient phase on the way toward the goal of total disarmament.

Fundamentally, mutual deterrence stands upon the premise that it is now possible, or soon will be possible, to create offensive weapons systems sufficiently invulnerable to enemy attack to prevent their destruction by any practicably achievable force. In this circumstance there will be no need to fear an enemy surprise attack undertaken specifically to wipe out the force. If each side has a similarly protected and invulnerable force, there will be no opportunity and therefore no incentive for either to build up a so-called counter-force capability. In this situation, an attack is deterred by the certain knowledge that it will be followed by a devastating reply.

Obviously any of the existing delivery systems can be used as part of a stable deterrent system. Because bomber aircraft normally require large airfields for their operation and appear to be harder to protect than ballistic missiles, missiles are the favorite weapon for planning deterrent systems. Though it may be regarded as a gross oversimplification by the experts, this discussion will ignore the very great complications of the multiple weapon problem and consider the pure ballistic missile case.

In order to destroy missiles installed in protected underground bases and missile systems protected by mobility (Polaris missiles in submarines, or mobile Minuteman missiles, for example), an attacker would be forced to launch many missiles for each one being attacked. It is easy to conceive of situations in which the exchange rate could be ten or greater. If both sides in a military contest develop secure weapons, much of the incentive for an unlimited arms race disappears, even without controls. The ability to achieve

* Leo Szilard, "How to Live with the Bomb and Survive," Bulletin of the Atomic Scientists (1960). 16:58.

relatively secure retaliatory systems makes it appear feasible to control the size of such forces by agreement. To do so requires only strategic inspection techniques, i.e., inspection methods which keep account of force levels rather than of the momentary readiness of forces.

There is a minimum size to a given deterrent force below which it may not provide security. This is determined by vulnerability of the missiles and the number it may be possible for the opponent to hide without serious danger of detection. This, in turn, obviously will be a function of the effectiveness of the missile inspection system. Herein lies the useful feature of the deterrence concept for the design of an arms-control system; there can be a mutual deterrence system to fit any desired level of inspection and the better the inspection the smaller the deterrent force required. This provides a possible means of beginning arms limitations with only a modest inspection effort and a corresponding modest reduction in force, and allowing the system to evolve in the direction of fewer weapons and more inspection as confidence in it is built up.

It is important to note that a missile deterrent system would be unbalanced by the development of a highly effective anti-missile missile and if it appears possible to develop one, the agreements should explicitly prohibit the development and deployment of such systems. Dealing successfully with the ballistic missile-control problem will be a key part of a comprehensive arms-limitation and control system using stable deterrents.

It is possible to design a stable deterrent system using only a relatively small number of ballistic missiles together with an inspection and control system which can provide a high degree of assurance that there remains no clandestine force sufficiently strong to be a serious threat to the legal deterrent forces. This can be shown by a simple example. Let us assume that the deterrent force consists of a number of Minuteman missiles installed in underground concrete emplacements. Depending upon the thickness of the concrete protection and other features in the design, the missile can be made secure against shock waves corresponding to overpressures up to about 1,000 pounds per square inch, though designs in the region between 100 and 300 psi are considered more practical. A 300 psi overpressure corresponds to the effect of a five-megaton

McGRAW-HILL. Encyclopedia of World Biography V. 10, 1973.

He then added ATP to the water and found that the threads contracted to about 10 percent of their original length. In 1942 actin was isolated and characterized by Szent-Györgyi's pupil F. B. Straub, and in 1943 Szent-Györgyi prepared crystalline myosin and worked out a method for its purification.

In 1949 Szent-Györgyi introduced the glycerinated fiber bundle; a strip of muscle treated with glycerol can be kept for study of the effects of ATP. In 1952–1953 he studied the "staircase effect" in heart muscle and the action of drugs on it.

Later Life

During World War II Hungarian leaders asked Szent-Görgyi to try to rescue Hungary from the Nazi stranglehold. He made an adventurous journey to Istanbul to consult with British and American diplomats. On his return he found that Hitler had personally demanded his delivery. Smuggled by friends out of Budapest, he hid near the Soviet lines. Rescued on Molotov's personal order, he was taken to Moscow and treated as a distinguished scientist. After the war Szent-Györgyi accepted the chair of medical chemistry at Budapest, and he also tried to help Hungary by political activity. But it was impossible to counteract Communist influence, and in 1947 he emigrated to the United States, where he founded the Institute for Muscle Research at Woods Hole Marine Laboratory, Mass.

Szent-Györgyi received many honors, including the Cameron Prize of Edinburgh University (1946) and the Lasker Award (1954), and he was a member of many scientific societies in several countries. Among his most important books are *On Oxidation, Fermentation, Vitamins, Health and Disease* (1939), *Chemistry of Muscular Contraction* (1947), *Chemical Physiology of Contraction in Body and Heart Muscle* (1953), and *Bioenergetics* (1957).

Further Reading

Albert von Szent-Gyöıgyi is listed in the Science study guide (VII, D, 2 and 4). Others who worked in his fields were Sir F. Gowland HOPKINS, Otto MEYERHOF, and Hugo THEORELL.

There is a biography of Szent-Györgyi in *Nobel Lectures, Physiology or Medicine, 1922–1941* (1965), which also includes his Nobel Lecture. For the history of ascorbic acid see F. Bicknell and F. Prescott, *The Vitamins in Medicine* (1953). For biological oxidation see C. W. Carter, R. V. Coxon, D. S. Parsons, and R. H. S. Thompson, *Biochemistry in Relation to Medicine* (1959). For muscle biochemistry see G. H. Bourne, ed., *The Structure and Function of Muscle*, vol. 2 (1960), and Dorothy M. Needham, *Machina Carnis* (1971).

* * *

SZILARD / By Bernard Jaffe

The Hungarian-born theoretical physicist Leo Szilard (1898–1964) made a significant contribution in the United States to the initiation and completion of the world's first atomic bomb.

Leo Szilard (pronounced sē′lärd) was born in Budapest on Feb. 11, 1898, the son of Louis and Thekla Vidor Szilard. He studied at the University of Berlin, where, after receiving a doctoral degree in 1922, remained as Albert Einstein's assistant in physics until 1925 and then for 5 years as privatdozent. He was an outspoken opponent of Nazism, and a few days after the Reichstag fire, in April 1933, he took a train for Vienna. From there he made his way to Oxford, England, where he did research in nuclear physics at the Clarendon Laboratory. Five years later he went to Columbia University as a member of the staff of the National Defense Research Division.

Early in 1939 both Szilard and Enrico Fermi confirmed the reality of nuclear fission, which had been announced by Otto Hahn and Fritz Strassmann in Germany in January. Szilard wrote, "I knew that the world was headed for sorrow." He went to see Einstein and then persuaded Alexander Sachs to deliver a letter from Einstein to President Franklin Roosevelt warning him that "extremely powerful bombs of a new type" might be built by the Germans, based on atomic fission. Roosevelt immediately appointed the Advisory Committee on Uranium, which included Szilard, and in August 1942 the Manhattan Engineer District Project was ordered to build an atom bomb. Fermi and Szilard, who had had early engineering training, worked out the lattice structure of the first atomic pile, which on Dec. 2, 1942, produced the first successful self-sustaining nuclear chain reaction in history. Meanwhile, Szilard was named chief physicist of the Metallurgical Laboratory at the University of Chicago.

In 1943 Szilard became a naturalized American citizen. As the completion of the bomb approached, Szilard became one of the chief contributors to the James Franck report, which counseled Washington against the intro-

Leo Szilard in 1945. (United Press International Photo)

duction of the atomic bomb as a legitimate war weapon against Japan. Nevertheless, on Aug. 6, 1945, the bomb was dropped on Hiroshima. Szilard became the crusading scientist, the leader of atomic scientists bent on bringing to Congress and the American people the fearful implications of nuclear war. In 1947 he formed the Emergency Committee of Atomic Scientists with Einstein as chairman, and he also sparked the movement for the civilian control of atomic energy. During the following year he tried unsuccessfully to see Truman, ~~Stalin~~, and Khrushchev in an effort to get united action against a nuclear arms race. He addressed students and faculties around the country and organized the Council for a Livable World in Washington.

he saw Khrushchev

When cancer struck him, Szilard refused surgery and took radiation treatment instead. During his long illness, Dr. Gertrude Weiss, professor in the medical school of the University of Colorado, whom he had married in 1951, helped nurse him to recovery. In 1960 he received the Atoms for Peace Award. Early in 1964 he became a member of the Salk Institute for Biological Studies in La Jolla, Calif.; he died on May 30, 1964.

In 1961 Szilard's imaginative and stimulating book, *The Voice of the Dolphins*, was published. This was a collection of five short stories set in the future—parables, in a way, for the nuclear age.

Further Reading

Leo Szilard is listed in the Science study guide (VII, C, 4). Others who contributed to the development of the atomic bomb were James CHADWICK, Enrico FERMI, Otto HAHN, and J. Robert OPPENHEIMER.

Many biographical anecdotes are in Szilard's interview reproduced in the book by the Editors of International Science and Technology, *The Way of the Scientist: Interviews from the World of Science and Technology* (1967). A biography of Szilard by E. P. Wigner is in National Academy of Sciences, *Biographical Memoirs*, vol. 40 (1969). Memoirs of Szilard are included in Bernard Bailyn and Donald H. Fleming, eds., *The Intellectual Migration: Europe and America, 1930–1960* (1969).

* * *

BIBLIOGRAPHY

I. ORIGINAL WORKS. The first co... of the writings of Synesius was by Dionysiu... ius (Paris, 1612). Most readily available is the ...on in J. P. Migne, *Patrologia Graeca*, LXVI (P... 364), 1021–1756. The *Epistolae* were edited b... rcher in his *Epistolographi Graeci* (Paris, 187... ench trans. of the works of Synesius was ... by H. Druon (Paris, 1878). Augustine F... lished English translations in *The Lette... ius of Cyrene* (London, 1926) and *The Es... ymns of Synesius of Cyrene* (London, 1930).

II. SECONDARY LITERA... ailed bibliographies of special studies on Sy... in W. S. Crawford, *Synesius the Hellene* ...); in José C. Pando, *The Life and Times o... yrene as Revealed in His Works* (Washing...)); and in Richard Volkmann, *Synesius v...* ..., 1869).

The scientific achiev... sius are discussed in B. Kolbe, *Der Bishof Synesius von Cyrene als Physiker und Astronom* (Berlin, 1850); and in Paul Tannery, *Recherches sur l'histoire de l'astronomie ancienne* (Paris, 1893), 50–53.

On the supposed authorship of the alchemic tract, see *Bibliotheca chemica*, John Ferguson, ed., II (Glasgow, 1954), 421–422; and especially Edmund O. Lippmann, *Entstehung und Ausbreitung der Alchemie* (Berlin, 1919), 96–98.

KARL H. DANNENFELDT

SZEBELLÉDY, LÁSZLÓ (*b*. Rétság, Hungary, 20 April 1901; *d*. Budapest, Hungary, 23 January 1944), *analytical chemistry*.

Szebellédy was the son of Ferenc Szebellédy, a pharmacist, and Maria Pohl. He earned a degree in pharmacy at the University of Budapest in 1923, but instead of becoming a pharmacist he turned to scientific research. In 1925 he was named assistant to Lajos Winkler at the Inorganic Chemistry Institute of the University of Budapest. An outstanding analytical chemist, Winkler had become famous for his methods of determining the amount of oxygen dissolved in water (1888) and the iodine-bromine number of fats for his work in precision gravimetry, and for his books. Szebellédy collaborated in Winkler's analytical research. His first independent publications (1929) dealt with the classical methods of analysis. He later spent considerable time away from Budapest working with foreign scientists, notably Wilhelm Böttger at Leipzig and William Treadwell at Zurich. In 1934 Szebellédy qualified as a lecturer in analytical chemistry at the University of Budapest, and in 1939 he was appointed professor of inorganic and analytical chemistry. The extensive program of research that he subsequently undertook was prematurely halted by his death from cancer.

Among the topics that Szebellédy investigated was catalytic ultramicroreactions, introduced into analytical chemistry by I. M. Kolthoff and E. B. Sandell for cases in which it is possible to obtain an accurately measurable endpoint (1937). Most catalytic color reactions, however, proceed continuously. Working with Miklós Ajtai, Szebellédy devised the analytical application for this type of reaction (1939). With the assistance of his young co-worker Zoltán Somogyi (whose death during an air raid preceded his own), Szebellédy invented the coulometric titration method (1938), which is widely used in analytical chemistry.

BIBLIOGRAPHY

Szebellédy's paper on coulometric titration is "Die coulometrische Analyse als Präzisionsmethode," in *Zeitschrift für analytische Chemie*, 112 (1938), 313–336, written with Z. Somogyi; and that on catalytic analysis is "Die quantitative Bestimmung von Vanadin mittels aktivierter Katalyse," in *Mikrochemie*, 26 (1939), 87–94, written with M. Ajtai.

A secondary source is F. Szabadváry, *History of Analytical Chemistry* (Oxford, 1966), 190, 316, 317.

F. SZABADVÁRY

SZILARD, LEO (*b*. Budapest, Hungary, 11 February 1898; *d*. La Jolla, California, 30 May 1964), *physics, biology*.

Szilard, one of the most profoundly original minds of this century, contributed significantly to statistical mechanics, nuclear physics, nuclear engineering, genetics, molecular biology, and political science.

The oldest of three children of a successful Jewish architect-engineer, he was a sickly child and received much of his early education at home, from his mother. His electrical engineering studies were interrupted by World War I; drafted into the Austro-Hungarian army, he was still in officers' school at the end of the war. In 1920 he went to Berlin to continue his studies at the Technische Hochschule. The attraction of physics proved too great, however, and he soon transferred to the University of Berlin, where he received the doctorate in 1922. His dissertation, written under the direction of Max von Laue, showed that the second law of thermodynamics not only covers the

Dictionary of Scientific Biography v. XIII.
(Scribner's, 1976)

mean values of thermodynamic quantities but also determines the form of the law governing the fluctuations around the mean values. The continuation of this work led to his famous paper of 1929, which established the connection between entropy and information, and foreshadowed modern cybernetic theory.

During this period in Berlin, as a research worker at the Kaiser Wilhelm Institute and then as *Privatdozent* at the university, Szilard undertook experimental work in X-ray crystallography with Herman Mark. He also began to patent his long series of pioneering discoveries, including devices anticipating most modern nuclear particle accelerators. With Albert Einstein he patented an electromagnetic pump for liquid refrigerants that now serves as the basis for the circulation of liquid metal coolants in nuclear reactors.

Hitler's assumption of power caused Szilard to leave Germany for England in 1933. There he conceived the idea that it might be possible to achieve a nuclear chain reaction. Szilard's search for an appropriate nuclear reaction (he early realized that the neutron was the key), while a guest at St. Bartholomew's Hospital in 1934 and at the Clarendon Laboratory, Oxford, after 1935, led to the establishment of the Szilard-Chalmers reaction and the discovery of the γ-ray-induced emission of neutrons from beryllium. It was only after he came to the United States, in 1938, that he learned of the discovery of fission in Germany by Hahn and Strassmann.

Szilard instantly recognized—as did nuclear physicists in other countries—that fission would be the key to the release of nuclear energy, and he immediately undertook experiments at Columbia University to demonstrate the release of neutrons in the fission process and to measure their number. With Fermi he organized the research there that eventually led to the first controlled nuclear chain reaction, on 2 December 1942, at Chicago. Probably more than any other individual, Szilard was responsible for the establishment of the Manhattan Project: it was he who arranged for the letter from Einstein to President Roosevelt that brought it about. His contributions to the success of its plutonium production branch, both in physics and in engineering, were manifold, especially in the earliest stages. The basic patent for the nuclear fission reactor was awarded jointly to Fermi and Szilard in 1945, but Szilard never realized any financial profit from it.

The last months of the war found Szilard, with James Frank and other Manhattan Project scientists, engaged in a futile effort to convince President Truman to use the first atomic bomb in a nonlethal demonstration to the Japanese of its destructive power.

After the war Szilard turned to biology. With Aaron Novick he invented and constructed a device for studying growing bacteria and viruses in a stationary state by means of a continuous-flow device, called the chemostat, in which the rate of bacteria growth can be changed by altering the concentration of one of the controlling growth factors. He used it for a number of years in fundamental studies of bacterial mutations and various biochemical mechanisms.

In the late 1950's Szilard became increasingly interested in theoretical problems of biology; his 1959 paper "On the Nature of the Aging Process" still stimulates research and controversy. His last paper, "On Memory and Recall," was published posthumously.

Throughout his life Szilard had a profoundly developed social consciousness. On fleeing Nazi Germany to England, one of his first acts was to inspire the organization of the Academic Assistance Council, to help find positions in other countries for refugee scientists. He was one of the leaders of the successful postwar Congressional lobbying effort by Manhattan Project alumni for a bill establishing civilian control over peaceful development of nuclear energy. Szilard was one of the instigators and active early participants in the international Pugwash Conferences on Science and World Affairs, and he wrote extensively on questions of nuclear arms control and the prevention of war. In 1962 he founded the Council for a Livable World, a Washington lobby on nuclear arms control and foreign policy issues.

Szilard was a fellow of the American Physical Society, the American Academy of Arts and Sciences, and the National Academy of Sciences. He received the Einstein Award in 1958 and the Atoms for Peace Award in 1959.

BIBLIOGRAPHY

Many of Szilard's works are being brought together in *Collected Works of Leo Szilard: Scientific Papers*, Bernard T. Feld and Gertrude W. Szilard, eds. (Cambridge, Mass., 1972–). His writings include "Über die Ausdehnung der phänomenologischen Thermodynamik auf die Schwankungserscheinungen," in *Zeitschrift für Physik*, 32 (1925), 753–788, his diss.; "Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen," *ibid.*, 53 (1929),

840–856, translated as "On the Decrease of Entropy in a Thermodynamic System by the Intervention of Intelligent Beings," in *Behavioral Science*, 9 (1964), 301–310; "Chemical Separation of the Radioactive Element From Its Bombarded Isotope in the Fermi Effect," in *Nature*, 134 (1934), 462, written with T. A. Chalmers; *The Voice of the Dolphins, and Other Stories* (New York, 1961); a report to the secretary of war (June 1945), written with James Frank, Donald J. Hughes, J. J. Nickson, Eugene Rabinowitch, and Joyce C. Stearns, and a petition to the president of the United States (17 July 1945), in Bulletin of the Atomic Scientists, *The Atomic Age*, M. Grodzins and E. Rabinowitch, eds. (New York, 1963); and reminiscences, in Donald Fleming and Bernard Bailyn, eds., *The Intellectual Migration: Europe and America, 1930–1960* (Cambridge, Mass., 1969).

On his life and work, see the notice by Eugene P. Wigner, in *Biographical Memoirs. National Academy of Sciences*, 40 (1969), 337–341.

BERNARD T. FELD

amounts of acid and the strengths of acids, most of them dealt only with the former. Physio gists and biologists, however, were more c cerned with the strengths of acids, since sm changes in acidity play a great role in various processes. They were therefore the ones to elu date the concepts underlying the treatment of th questions and to develop appropriate techniq of measurement. The first to do so was Szi who in 1903 published "Indikátorak alkalmazás állati folyadékok vegyhatásának meghatározásá ("Application of Indicators in the Determinati of the Reaction of Animal Fluids"), in *Orvosi H tilap*, 45 (1903), 509–518. After establishing t the reaction of animal fluids—the hydrogen concentration of blood serum, for example—c not be determined titrimetrically, Szily hit upon idea of using the indicators for this purpose, si each indicator changes color at a specific hydro ion concentration, regardless of the nature of base. By using various indicators he was able

SZILY, PÁL (*b.* Budapest, Hungary, 16 May 1878; *d.* Mosonmagyaróvár, Hungary, 18 August 1945), *chemistry.*

Szily came from a family of physicians. His father, Adolf Szily, was a doctor and director of a Budapest hospital, and his older brother became a professor of ophthalmology at the University of Budapest. Szily studied medicine at the University of Budapest and after obtaining his medical degree became an assistant at the Institute of Physiology there, where he carried out his fundamental research on the colorimetric determination of hydrogen ion concentration.

Since the time of Robert Boyle various plant juices had been used to determine whether a liquid was acidic or basic. When synthetic substances were introduced as indicators, it was observed that they did not change color at the same level of acidity as the natural juice indicators. On the basis of Arrhenius' theory of ionization (1887), Wilhelm Ostwald introduced the concept of the dissociation constant with a view to ascertaining the strengths of acids and bases as a function of, respectively, hydrogen ion and hydroxyl ion concentration. He also determined the value of the dissociation constant of water. In 1893 Max Le Blanc invented the hydrogen electrode, which made it possible to measure the hydrogen ion concentration electrochemically.

It appears, however, that for a long time chemists were unable to recognize the significance of these developments. They did not comprehend the difference between titrimetrically determinable base. By using various indicators he was able establish a scale for estimating acidity. In additi employing seven different indicators, he devise scale for making an approximate determination the acidity of the blood serum. In the course of t research he also determined the resistance of bl serum to the effects of acids and bases (its bu property).

In 1903 Szily lectured on his results before Physiology Society of Berlin; and Hans Fried thal, a lecturer at the University of Berlin, ranged for Szily to continue his research the Friedenthal began investigations in the same a and perfected Szily's method by using a lar number of indicators and by employing stand (buffer) solutions of precisely known hydrogen concentration. In 1904 he reported that he been unsuccessful in his attempt to produce th solutions by successive dilution of acidic or ba solutions. Szily suggested that he prepare sta solutions of reliable hydrogen ion concentrati by mixing primary and secondary phosphates different proportions. Szily was, consequently, inventor of artificial buffer solutions. Research this area was extended by S. P. L. Sørensen, w introduced the concept of pH in 1909.

In 1905 Szily transferred to the surgery clinic the University of Budapest, and in 1909 he came director of the serological and bacteriologi laboratory of the Budapest Jewish Hospi Henceforth his research was of a purely medi nature. He investigated the therapeutic effects Salvarsan and communicated his findings to P Ehrlich, who followed with interest the results

CLEVELAND, OHIO
PRESS AND NEWS
D. 381,987
NOV 29 1961

First A-Bomb Builder Here for Peace Talk

By BUD WEIDENTHAL

One of the scientists responsible for the creation of the first atomic bomb will unveil his plan to avert nuclear disaster in a speech here tonight.

"I believe that we are headed toward an all-out war," said Prof. Leo Szilard, 60-year-old University of Chicago physicist who holds the patent on the control process of the first nuclear chain reaction.

"The chances of getting through the next 10 years without averting a disaster are slim," he added in an interview today.

"But I personally find myself in rebellion against the fate that seems to be in store for us," said the scientist who left a hospital bed a year ago to begin his personal crusade against the atomic arms race.

Advice to Clevelanders

Szilard indicated he would tell Clevelanders tonight what they might do to help. The address is scheduled for 8:15 in Severance Hall. It is one of the McBride lecture series sponsored by Western Reserve University.

Szilard was one of the small group of scientists who alerted President Roosevelt in 1939 to developments in atomic reactors both in the U. S. and Germany. They urged FDR to develop the bomb before Germany.

He was one of five nuclear scientists on hand when the first controlled nuclear chain reaction took place at the University of Chicago in 1942. Following the war he was among the first to ask for a halt to the atomic arms race.

Prof. Szilard said today he was discouraged after spending a year in Washington trying to convince government officials of the hazards of the nuclear arms buildup.

Discouraged in Washington

"There is no market for wisdom in Washington," he said. He said government officials were too concerned with day-to-day crises. "There are too many pressures" said Szilard.

He said tonight's suggestions would be in the form of an "experiment" to test reaction to his ideas. He is giving a similar speech at Harvard Law School, Swarthmore College and the University of Chicago.

Szilard said his ideas are based on discussion with American officials, a two-hour conference with Russian premier Khrushchev and with Russian scientists at two Pugwash conferences.

THE PLAIN DEALER, THURSDAY, NOVEMBER 30, 1961

Atomic Pioneer Asks Campaign to End War

Dr. Leo Szilard

A Movement for Abolishing War was proposed last night by one of the scientists who helped to create the atomic bomb.

Dr. Leo Szilard drew a capacity crowd of 1,800 to Severance Hall for one of the McBride lecture series sponsored by Western Reserve University.

Cleveland became one of four areas where Dr. Szilard is conducting what he calls an experiment. The movement also is being offered in talks at the Harvard University Law School Forum, the University of Chicago and Swarthmore College, all in 10 days.

Szilard envisions a Council for Abolishing War, consisting of perhaps a dozen distinguished scientists. It would be the board of directors for a lobby that would pursue specific political objectives he listed.

Asks 2% of Income

The 60-year-old physicist, who holds the patent of the control process of the first nuclear chain reaction, would expect supporters of his movement to contribute 2% of their annual income.

Most of it would go to candidates for public office pledged to Szilard's program, which he spelled out in an hour-long talk and then explained further in a question period.

He would resist with political action the adoption of a "first strike if necessary" policy by the United States. He favors "a decision to the effect that America is going to maintain an invulnerable second strike."

"America should unilaterally proclaim that she would not resort to any . . . bombing . . . except if American cities or bases are attacked by Russia or if there is an unprovoked attack on . . . one of America's allies," he says.

"America should proclaim that if in case of war she were to use atomic bombs against troops in combat she would do so only on her own side of the prewar boundary," he continued.

Szilard listed these other points:

- "America should unilaterally resolve that atomic bombs and the means (of delivery) which are supplied by her and stationed in Europe remain in the hands of American military units under American command rather than be placed under the control of NATO."
- "The President should issue an executive order against fighting meaningless battles in the cold war." He cited the recent election of a Swede to head the International Atomic Energy Agency in Vienna over Soviet protests.

Several times he cited the need for private citizens to act, acquiring voting power and exercising it.

Sees Disarmament Possible

He mentioned a disarmament agency, saying that disarmament progress "could probably be made through serious nongovernmental discussions among Americans and Russians.

"I believe that such discussions ought to be arranged through private initiative," he added.

"An influential private group" also was suggested for devising forms of democracy suitable for Southeast Asian and African nations, and for developing methods of birth control for areas with population problems.

Szilard distributed 500 copies of his speech to members of the audience who requested them during an intermission, and asked each listener to try during the Christmas vacation to find out how many persons would be interested in participating in his movement.

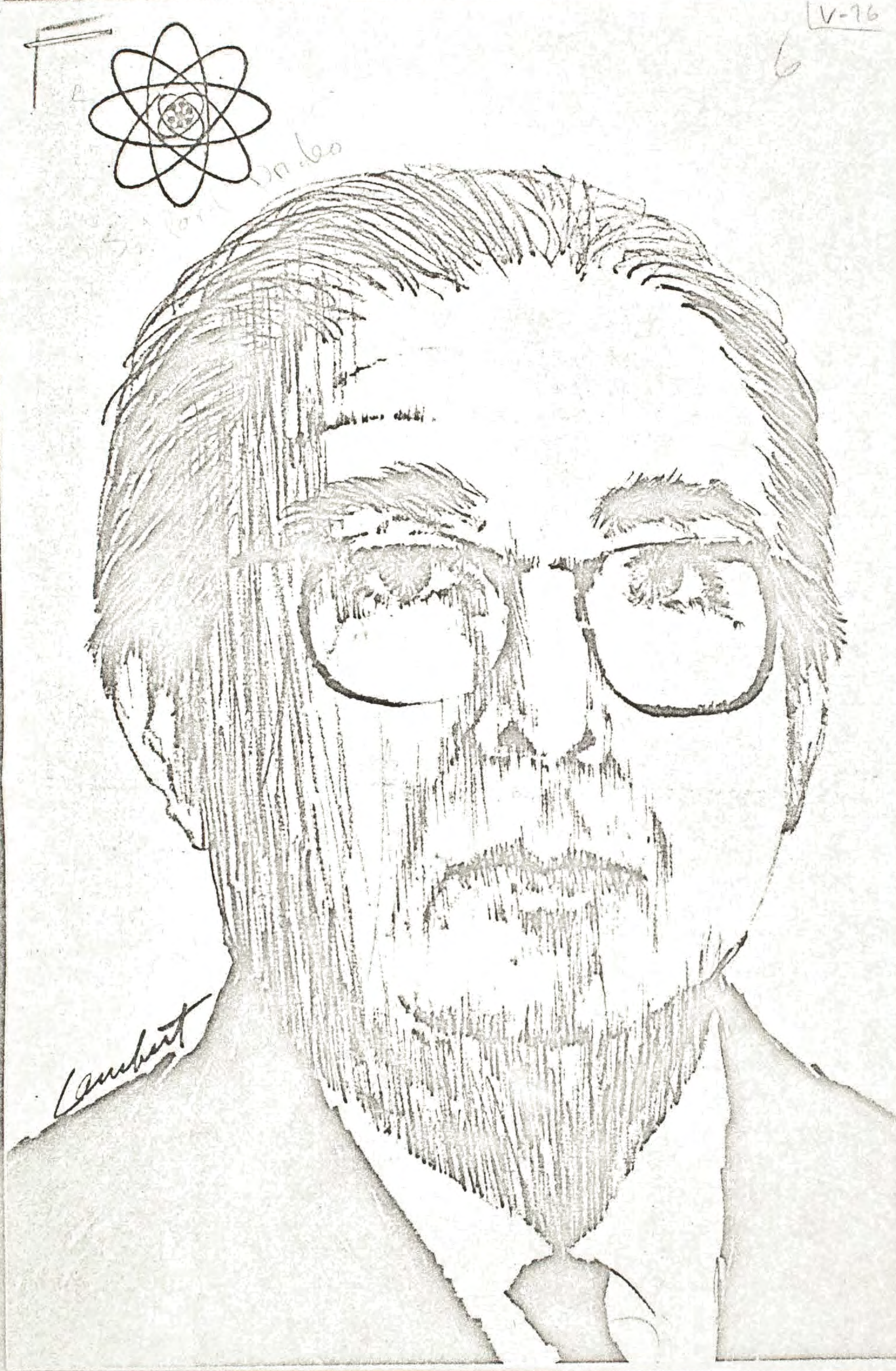
After Christmas, he said, when he received the results, he could tell whether such a movement would be successful.

PAGEANT
NEW YORK, N.Y.
MONTHLY 500,000

DEC 1961

V-76

6



Unnoticed by most passers-by, one of the great scientists of our time works quietly at a desk in a Washington hotel. It was he who sparked the development of the atomic bomb. Now, despite a cancer expected to take his life months ago, his interests have never been more varied—from universal peace to a gadget that makes instant tea

The Legend That Is Dr. Szilard

BY THEODORE IRWIN

EARLY LAST YEAR newspaper columnists reported that Dr. Leo Szilard had only six weeks to live. Yet one morning recently I found him seated at a desk in the lobby of a hotel in Washington, D.C. With people eddying around him, Dr. Szilard was calmly working on a scientific paper of potentially far-reaching significance.

Few, if any, of the guests and visitors in the hotel lobby recognized this gray-haired, round-faced man. A lazy-eyed look belies his brilliant and fantastically versatile mind. Though he's a living legend, Dr. Szilard has always seemed to move in an aura of mystery.

Dr. Szilard—now 63 and supposedly dying of cancer—has performed a unique role in modern history. With physicist Enrico Fermi, he held the first patent on the atomic chain reaction, which they assigned to our government.

It was Dr. Szilard who convinced his old friend Albert Einstein that an atomic explosive was practical and that Einstein should so inform President Roosevelt. Einstein's subsequent letter set in motion the development of the first atom bomb.

Characteristically, however, Dr. Szilard vigorously opposed dropping the A-bomb on Japan. For years now he has crusaded for arms control and disarmament—Dr. Szilard's cancer must wait while he dedicates himself to saving the world from suicide. To him, what happens in Berlin, Cuba and Tunisia—the fight for peace—is far more important than his own fight for life.

His cancer of the bladder was of a highly malignant type. "It did look very bad," he admitted to me. He spent about a year at a New York hospital, keeping himself

busy with correspondence. In January 1960, he was given radiation treatment, and so far he has responded to it. Now he has what he calls "some minor residual surgical problems"; he carries a drainage bag attached to a tube in his bladder, but the only outward sign is his holding a hand to his side while walking.

"I don't believe my cancer is licked," he said to me matter-of-factly. "My time is probably limited. But everyone's time is limited, isn't it?"

We took over a sofa in the hotel lobby as Dr. Szilard talked freely about what was on his mind. Despite his illness and evident discomfort, he sparked energy and continually displayed his masterly sense of irony. It became clear that here was an unassuming, deep-thinking, sharp-tongued intellectual maverick.

"Cancer is grossly overrated," he went on. "People worry about it because it's such a frightening disease. But if a cure were found, those who are cured would merely die later of some other ailment. A cure for cancer would add only about two and a half years to the life span of the average adult. Cancer is predominantly a disease of older people, and the basic process of aging is left untouched by anything medicine can do."

Why has he come to Washington to do his work?

"The four years of the Kennedy administration," he replied, "might well set the course of events for a generation. I want to know what's going on and I can't find out just by reading the newspapers. So I've come to see it all at close range—to catch the flavor and to appraise the trend of what's happening. I see many people, including some of the President's advisers. I listen to them, and maybe sometimes they listen to me."

Dr. Szilard selected his hotel—the DuPont Plaza, about 15 minutes from the White House—because it has a large, light-filled lobby where he can work. To a desk generally used by guests to write notes home to the family, he customarily brings a slide rule and a folder bulging with memos, reports and correspondence. He feels cramped in his 12-by-15 room, where his papers are piled high on a row of coffee tables. And he doesn't mind distractions.

"Perhaps it's better if an idea does not become conscious too early," he said. "If distractions can keep an idea from emerging prematurely, it can continue to grow in the subconscious."

THERE'S NO EVIDENCE that illness is obstructing the avalanche of Dr. Szilard's ideas. One of our most versatile scientists, he has labored in the realms of nuclear physics, chemistry, biology, radiology and, currently, microbiology. Dr. Szilard has been described as an "idea factory," and even he thinks of himself as basically an inventor rather than a scientist.

In addition to his solid accomplishments in nuclear physics, Dr. Szilard has made big dents in sundry other fields. Not long ago he published a provocative paper on the aging process, and it may have a revolutionary significance. His is the first scientific theory intended to supply the long-elusive answers to such questions as "How do we be-

DR. SZILARD NAMES THE KEY PROBLEMS OF OUR TIME

The issue of disarmament Dr. Szilard considers one of the five most important problems of our time. The others:

- "**We must invent new forms of democracy** which will be capable of functioning in the various underdeveloped regions of the world. If the parliamentary form of democracy is imposed on new countries—like Ghana, for instance—the first government in office might take steps to perpetuate itself."
- "**It is necessary to develop new forms of birth control** which will meet the needs of countries like India. The first thing that happens when certain overpopulated regions are given economic aid is that infant mortality goes down while the birth rate remains unchanged. As a result, the population shoots up so fast that no economic growth can keep pace with it."
- "**We shall need to rearrange our leisure time.** If there is no war, working hours may drop within the predictable future to thirty-two hours a week in America. This would mean three-day weekends, which make no sense at all. Rather, we ought to have one-day weekends and three months' paid vacations. This would build up the vacation industry. Many people would take their vacations abroad, and what they would spend abroad might take the place of grants-in-aid."
- "**Perhaps the time has come to try to get rid of sleep.** The mechanism which forces us to go to sleep developed during the evolution of man, at a time when—during the darkness of night—sleep may well have been the most useful kind of activity. If we did not have to sleep, this would mean our living time could be extended fifty per cent."

gin to die?" and "Just where does the mysterious stroke of death originate?" Roughly, his complex theory holds that the age at death is determined by one's genetic make-up.

Shortly after completing this paper, he started ruminating about the mechanism of antibody formation (immunity). For three years a link in his theory was missing; then, on a plane from Stockholm to New York, the big idea struck him and "the whole thing started to make sense." He spent the next few months writing two papers on the subject.

"This is how science progresses," he said. "But don't ask me to explain my theory to laymen," he added, smiling. "I can't do it."

As a pastime, generally during summers, Dr. Szilard has occupied himself with all kinds of curious notions and schemes. "I can't deal with major problems all the time," he said. "I'd get stale."

He has come up with a gadget that makes instant tea, explored ways to accelerate checking counters at supermarkets, pointed out loopholes in our tax laws, dreamed about improvements for injector

razors, and once proposed that we have dual currency—green dollars for wages, red for credit in the bank. His plan for the financing of universities is as complicated as a Rube Goldberg madcap gadget.

When the problem of population control captured his fancy, Dr. Szilard learned that beads used by women in India for determining their infertile periods often slipped out of place. So he devised a clasp to keep the beads in line.

Global affairs have always intrigued him. Early in 1947, Dr. Szilard proposed that the United States supply economic aid on a vast scale to countries in Europe and elsewhere to build up their industries. The Marshall Plan came three months later.

Unlike most people, Dr. Szilard doesn't find he has to relax periodically from his unending flow of ideas. But when he does, it's to listen to music, chiefly Beethoven and Mozart, or to read—Shaw, H. G. Wells, Boswell, and "English lady novelists." He hates to keep regular hours and schedules. Exercise? "When I feel the need, I lie down until the urge passes." He has never owned a home. "I would have liked to have roots," he confessed, "but if I can't have roots I settle for wings."

Notwithstanding his many interests, Dr. Szilard insists that he is never too busy. "Since my time may be limited, I plan ahead for three months. After that, with luck, I shall plan for another three months."

Currently he is on a ten-year, free-swinging research grant from the University of Chicago, which pays his and a secretary's salary and his travel expenses. It provides him with all the freedom he needs. At present Dr. Szilard is "looking for information" that may give him a clue to the mechanism of memory, one of his pet projects now.

He also wants to complete his memoirs. He has written 60,000 words but feels the book will require another quarter-million. "It will get across the thesis," he said, "that Homo sapiens resembles the apes in most respects, but that Homo sapiens is completely devoid of any imagination."

As proof he points out that for more than two years before World War II man was unable to see the meaning and importance of the atomic chain reaction.

Leo Szilard's memoirs should make fascinating reading. Born in Hungary, the son of a civil engineer, he studied electrical engineering in Budapest. Then he switched to physics, in which he received his doctorate degree, in Berlin. There he developed new concepts in thermodynamics and conceived the basic idea for the cyclotron, an atom smasher. With Albert Einstein, he also took out a patent on an electric contrivance for pumping liquid metals.

WHEN HITLER SEIZED power in 1933, Dr. Szilard flew to London. It was then that he entered what was at the time a new sphere of science—nuclear physics.

One day in 1934, as he paused at a street intersection in London, questions about the atomic chain reaction suddenly hit him like a bolt of lightning. What would happen if there was a chain reaction in which some element absorbed one neutron and discharged two? What could that element be?

For months he thought about it, usually in the most private place he could find—the bathtub in his hotel room. Already he could visualize the horrifying havoc that might be produced by the atomic process. His driving ambition was not to become a millionaire by exploiting the process but somehow to work out methods of controlling it.

In 1938, as war clouds loomed over Europe, Dr. Szilard came to the United States (he is now an American citizen). A year later, word filtered in that the uranium nucleus had been split by scientists in Europe. Dr. Szilard felt that the Germans were bound to create an atomic bomb.

On March 3, 1939, he and an associate, Dr. Walter Zinn, made what was to prove an earth-shaking discovery: their experiment showed neutrons being emitted in the process of fission. Almost simultaneously, Enrico Fermi and France's Frédéric Joliot-Curie made similar discoveries.

Dr. Szilard teamed up with Fermi at Columbia University, and from their work the design for the first self-sustained atomic chain reaction emerged.

High U.S. government officials had been skeptical of the early developments. On August 2, 1939, inspired by Dr. Szilard, Albert Einstein sent his celebrated letter to the President. It stated:

"Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future.

"Certain aspects of the situation which have arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration."

That letter produced results: the first Army and Navy grant—$6000—to aid atomic research at Columbia.

In 1945, when plans were made to drop the A-bomb on Japan, Dr. Szilard recalls that he opposed it "with all my power." He prepared a prophetic memorandum for FDR warning that the use of the bomb against cities "would start an atomic-arms race with Russia." He raised the question whether avoiding such a race might not be "more important than the short-term goal of knocking Japan out of the war."

To AVOID GOING through the regular channels, Dr. Szilard arranged to give his memorandum to Mrs. Roosevelt in a sealed envelope, which she could hand to the President.

Shortly before his meeting with Mrs. Roosevelt, Dr. Szilard heard the report over the radio: President Roosevelt was dead!

Later, when the scientist tried to see President Truman, he was shunted to James F. Byrnes, slated to be Secretary of State. Byrnes brushed him off. So Dr. Szilard drafted a letter to Truman, had it signed by some 60 atomic scientists and sent it to the President through official channels. To this day, Dr. Szilard doesn't know if the petition ever reached him.

Until 1946 Dr. Szilard worked at the University of Chicago's branch of the A-bomb project. Then, perhaps in revulsion against Hiroshima, he turned from physics to biology—

from death to life. His work in genetics unlocked important secrets about mutations and, with a young chemist, he developed the chemostat, a device for growing bacteria and observing mutations under controlled conditions.

Last year Dr. Szilard was awarded the Einstein Medal by the Strauss Memorial Fund for "outstanding achievement in natural sciences" and for his scholarship "in the broadest areas of human knowledge." Shortly afterward he received a Ford Atoms for Peace Award for his work on uranium fission in 1959, sharing $75,000 with another recipient.

Lately Dr. Szilard's memoirs have been pushed aside for other literary efforts. Purely for pleasure he wrote children's stories, which he didn't care to have published. Then there is his fast-selling new book of short stories, *The Voice of the Dolphin,* a special Szilard brand of science fiction. (It's available in paperback here and has editions in Italy, France, England and Germany.)

The off-beat stories—barbed with wit, irony and razor-sharp satire—usually carry a serious message. "When I tried to explain what disarmament would involve," he told me, "people did not understand me. In fiction, I find I can get across what I want to say."

In the title story, Dr. Szilard describes how the world achieves general disarmament—25 years hence. In other stories, Dr. Szilard pokes sophisticated fun at Communist bureaucracy, research foundations, and the foibles of scientists.

He is deriving a keen delight from the response to his book. Several fellow-scientists wrote him that they couldn't finish it—their college-age sons or daughters got hold of the book first and they never saw it again. Sociologists have urged that the book be classified as required reading in college.

As WE CHATTED in the hotel lobby, we were joined by his wife, Dr. Gertrud Szilard. Married ten years, they have no children. Mrs. Szilard, a trim, attractive physician, recently resigned her post at the University of Colorado Medical School to be with her husband; her specialty is preventive medicine and she is now Leo's personal doctor. ("Leo's chances are getting better every day," Mrs. Szilard confided to me later, over a Hungarian salami sandwich prepared for me in her kitchenette.)

Despite his unorthodox views, Dr. Szilard has never been under personal attack. "That's because I confuse them—I can't be pigeonholed," he said. And Mrs. Szilard added: "Leo has no ax to grind. He has no status problem and he doesn't give a hoot what other people think of him."

What may make him unacceptable in some quarters is his strong stand on disarmament. These days he is diligently writing memos on the subject and circulating them around Washington, and they manage to reach some of President Kennedy's advisers.

"General disarmament would not automatically guarantee peace," Dr. Szilard said, "but I believe that peace could be secured in a generally disarmed world if the nations were to accept what may be reasonably demanded from them on this score.

"The difficulties of instituting a

system of inspection that would eliminate the danger of secret evasions of a disarmament agreement are grossly overrated. But general disarmament will be politically acceptable only if there is a concomitant political settlement.

"A political settlement in Europe might not be too far away," the scientist went on, "but it does not seem to be within sight in the Far East.

"It may well be that some future historian will, in retrospect, diagnose the trouble with America in the mid-century as 'too much patriotism and too few patriots.'"

EXCLUDED FROM Dr. Szilard's pet projects is the challenge to reach the moon. "I don't object to spending twenty billion to get there," he says, "but only because if we must engage in a contest of prestige with the Russians, I prefer that it be centered around the moon rather than Cuba, Laos or Berlin."

Obviously Dr. Szilard considers his greatest contribution to be his investigation of the uranium chain reaction. He insists he has no sense of guilt about it, but he does feel it "may end badly." Could he place a dollar value on his work? His reply: "What is the value of having won the war? On the other hand," he added, dead-pan, "we may be all blown up and then maybe the government should sue me for damages."

THIS IS Dr. Leo Szilard, one of the illustrious minds of the century, an intellectual adventurer with an uncanny ability to conceive revolutionary ideas.

The cancer that threatens to cut his life short leaves him with an amazing stoicism.

"Death is part of life," he said to me. "If it didn't exist, one would have to invent it. There is nothing alarming in thinking that after your death you'll be in the same state as you were before birth."

He would even like to write his own epitaph.

"You're meant to perform some specific function in life, and you have no choice but to do it. I would like my epitaph to read, 'He did his best.'" ■■

Developer of Atom Bomb Proposes Scientist-Scholar Lobby for Peace

CHICAGO, Dec. 1 (UPI) Prof. Leo Szilard, atomic scientist, today proposed that scholars and scientists organize a lobby for peace.

Szilard, professor of biophysics in the Enrico Fermi Institute for Nuclear Studies at the University of Chicago, said the lobby would function as the nucleus of a Nation-wide "movement for abolishing war."

Szilard, a member of the scientific team that achieved the world's first sustained nuclear chain reaction in 1942, called for the peace lobby in a speech prepared for delivery at the University.

He proposed that the lobby work for a seven-point program designed to:

1. Reorganize American defense policy as "insurance" rather than as "deterrent.
2. Limit force to strategic bombing of cities or bases if the United States or its allies are attacked first and limit atomic bombing to territory being defended.
3. Keep American atomic weapons in control of the United States rather than NATO.
4. Get the President to issue an executive order against fighting "meaningless" battles in the cold war.
5. Improve the East-West cultural exchange program and limit the activities of the Central Intelligence Agency involving tourists.
6. Delegate a private group to help or prod Government agencies dealing with disarmament questions.
7. Permit an influential private group to help estabish democracies in under-developed nations.

Szilard also urged that the United States liquidate its military commitments.

"The Russians are very much aware of the great benefits they would derive from general disarmament," he said, "and I believe that the Soviet Union would be willing to pay a commensurate price for obtaining it."

LOBBY AGAINST WAR, A-BOMB PIONEER URGES

Szilard Acts to Rally U. S. Intellectuals

Leo Szilard, professor of biophysics in the University of Chicago's Enrico Fermi Institute for Nuclear and one of the scientists who helped to develop the atom bomb, disclosed plans yesterday for a nation-wide movement to "abolish war."

Szilard

Szilard, who said he fears that "chances of getting thru the next 10 years without war are slim," spoke yesterday before the division of social sciences and the law school of the university.

He proposed the creation of an intellectual pressure group of 500,000 persons who would contribute 2 per cent of their annual salaries to support lobbyists in Washington, D. C.

Tells Aim of Lobbyists

The lobbyists, all scientists, would help "intelligent men in Congress who have insight into what goes on to have the courage of their convictions," he explained, and see that those without such insight are "replaced with better men."

Szilard outlined "political objectives" he said should be sought in the next 12 months.

He called, first, for an end to the "first strike" policy. It is based on ability to strike Russia and Red China with such force that they would not be able to strike back in a nuclear war. He said a "first strike" policy would result in a "sky-is-the-limit" arms race.

"Second Strike" Plan Urged

Instead, Szilard proposed an invulnerable "second strike" force. He defined it as a force that could return a nuclear attack no matter how powerful. This policy would open the door to an agreement on arms control, he said.

He said he does not believe an agreement on arms control, both with Russia and Red China, could be made immediately. Therefore, he called for two unilateral agreements with them—first, that we would not bomb enemy cities or bases unless we or our allies were attacked; second, that in a war we would use atomic weapons for defense only, and only on our side of the pre-war boundary overrun by enemy troops.

Szilard said he believes we should also agree to retain American control of atomic bombs in Europe.

Szilard, who was born in Budapest, Hungary, Feb. 11, 1898, received his doctor of philosophy degree from the University of Berlin, but left Germany in 1933 when the Nazis came to power. He went to England and in 1934 began work in the field of nuclear physics in London, later continuing his research at Oxford university. He came to the United States in 1938 and until November, 1940, worked at Columbia university. Until 1942, he worked on the Manhattan project [original A-bomb].

In the fall of 1946 he joined the faculty of the University of Chicago as a professor of biophysics. He went on leave to work on a public health grant in New York City in 1959.

Szilard is married to the former Dr. Gertrud Weiss, a physician.

CHICAGO, ILL.
SUN-TIMES
D 556 219 S 648 '8
3 1961

Nineteen Years Later

Nineteen years ago today the first sustained nuclear chain reaction was accomplished by a group of scientists working under the west stands of Stagg Field at the University of Chicago, and the atom bomb became possible.

The change in the world since then is just as great as the difference between the 1942 scene under Stagg Field's stands, as a few men gathered around a scientific experiment, and the 1961 scene that Americans can only imagine when Russians recently exploded a 50-megaton bomb capable of ripping a hole in the earth more than five miles in diameter.

It is true that as Enrico Fermi and other scientists worked on the chain reaction in Chicago that London was in flames from German bombs. War was bringing human misery to Europe and the Pacific. But this was war of the kind humans had long endured, and survived. Even when the first V-2s dropped on London and the supersonic missile age began, the payload was only a little more than a ton of explosives. The work under Stagg Field's stands made possible a payload with the equivalent of 20,000,000 or 50,000,000 or 100,000,000 tons of dynamite. The very concept of war was changed when the U.S. dropped a relatively small A-bomb on Hiroshima on August 6, 1945, and killed between 70,000 and 80,000 persons.

The bomb also has changed the concept of peace. Nations possessing the bomb dare not use it against each other for fear of retaliation but can't agree to outlaw it. They have developed small model battlefield atomic weapons but wonder whether any nuclear war could be confined to the battlefield. The word "escalation" has come into common use in this consideration.

Nations might begin a conventional war believing it could be confined to a military front. But when one began to lose ground it might resort to nuclear tactical or battlefield weapons. The other would retaliate and both sides would then ride the escalator up to total destruction, small tactical bombs being followed by behind-the-lines bombs and finally the city-smashing ones.

Some views on the adjustments nations must make in their relations with each other because of the atomic bomb were given Friday by Prof. Leo Szilard, who was one of the scientists under Stagg Field's stands that historic night 19 years ago.

One proposal he makes is aimed at the problem of escalation. America would go further than to pledge that it would not use any bombs on Russia's cities or bases unless, unprovoked, Russia attacked Western cities or bases. America would state a policy for war that she would use atomic bombs against troops in combat only on the Western side of the prewar boundary. That is, tactical bombs would be used only to regain ground lost to an aggressor but not to carry the war over into the enemy's territory. This would pledge that atomic bombs would be purely defensive.

If Russia would be bound by such a pledge — as nations are bound by the Geneva convention against the use of poison gas—the danger of escalation would be reduced but nations would not be denied the protection of nuclear *defense*.

"This pledge," says Szilard, "would impose certain restrictions on the conduct of war, but if neither side would aim at anything approaching victory, then the pledge would greatly reduce the danger of all-out war."

What Szilard aims for is abolishment of war but he realizes that this cannot come about until nations change their attitude toward war. He is proposing that nations give up the usual purpose of war—victory over the enemy. There can be no victory for either side in a catastrophic nuclear war. He is proposing nations accept the concept that there can be no victory in a nonnuclear war, either as long as both sides hold the big weapon as a threat. Wars must end in virtual stalemates as did the Korean war.

This is a new concept for mankind to consider. But in the 19 years since the Stagg Field event, it has had to change many concepts. Szilard's idea may or may not be workable but the world certainly cannot measure the problems of the atom age with a 1941 yardstick.

NEW YORK, N.Y.
TIMES
D. 644,175 S. 1,293,658

DEC 3 1961

Scientist Would Form Council To Lobby for Abolishing War

2619

Szilard Wants Group to Have a Full-Time Staff for Pressure on Capital

By AUSTIN C. WEHRWEIN
Special to The New York Times.

CHICAGO, Dec. 2—Dr. Leo Szilard has announced the establishment of a Council for Abolishing War that could spend $25,000,000 a year lobbying for peace.

Dr. Szilard, a biophysics professor who drafted the letter the late Albert Einstein sent to President Franklin D. Roosevelt on the feasibility of an atomic bomb, said the council would be made up of seven to twelve distinguished scientists.

"These men," he said, "would speak with the sweet voice of reason, and our lobby could see to it that they shall be heard by the people within the Administration and also by the key people in Congress.

In a lecture at the University of Chicago yesterday. Dr. Szilard said that, without drastic political changes, the world was "headed toward an all-out war" that the council was one of a number of ways to avoid this course.

The council, he said, would be like a board of directors for the lobby. The lobby organization would have a full-time staff, the council would have a set of political advisers. It is intended to create a "movement for abolishing war."

Those who joined it would agree to contribute 2 per cent of their total income.

Expects Sharp Rise

Starting with a base of 50,000 students " who would go all out in support of the movement," Dr. Szilard estimated it could reach 500,000 members in twelve months.

He estimated that this would raise a found of $50,000,000.

He raised the possibility that the movement could grow to represent 2,000,000 votes. He said it would use every form of personal and group lobbying to influence politicians and editors, columnists, television commentators and all others who help to influence public opinion.

It would make direct contributions to political campaigns, and would promise to deliver votes. Members would promise to vote solely on the "issue of war and peace," disregarding domestic issues.

Dr. Szilard, who has been on leave from the University of Chicago's Enrico Fermi Institute for Nuclear Studies, was one of those who worked with the late Dr. Fermi when the group he led achieved the first sustained nuclear chain reaction at the University of Chicago campus on Dec. 2, 1942.

His lecture, which he will now take to Harvard University, Swarthmore and Western Reserve University, was sponsored by the University of Chicago Law School and the Division of Social Science. He based some of his conclusions on long personal talks he has had with Russians in their own country in recent years.

Political Objectives

Dr. Szilard's suggestion was grounded on the idea that it would be possible to formulate a set of political objectives "on which reasonable people could generally agree" and that it was conceivable that a sizable minority of the voting population could be counted on to give all-out support for such views.

Dr. Szilard said that the minority he had in mind would represent perhaps 10 per cent of the vote, but that its voice would be listened to if it could both deliver votes and make substantial campaign contributions. He said it would be "the most powerful lobby that ever hit Washington."

In outline, these were the political objectives he set for his movement:

¶American use of force should be limited to strategic bombing of cities or bases if the United States or its allies are attacked first.

¶If the atomic bomb is used for combat, it should be employed only in territory that is being defended.

Associated Press
Dr. Leo Szilard

¶American atomic weapons should remain in the control of American military commanders.

¶The President should issue an Executive Order against fighting "meaningless battles' in the "cold war."

The East-West cultural exchange program should be improved and intelligence activities involving tourists should be limited.

¶An influential private group should take the initiative in "helping or prodding" Government agencies dealing with disarmament questions.

¶An influential private group could be more effective in helping establish democracy in under-developed nations than new governmental bodies.

Seeks Unilateral Steps

"We ought to look to unilateral steps that America might take, in order to have the danger of war recede, rather than to an agreement on arms control," the scientist suggested.

"With President Kennedy, new men moved into the Administration and many of them fully understand the implications of what is going on and are deeply concerned," he went on. But he said:

"They are so busy trying to keep the worst things from happening on a day-to-day basis that they have no time to develop a consensus on what the right approach would be from the long-term point of view."

He said one step would be for the United States to "liquidate her military commitments —without loss of prestige and without seriously endangering the interest of the nations involved" in those countries that circle the Soviet Union.

Lobby For Peace

DR. LEO SZILARD was one of the pioneers in developing the system of nuclear reaction which enabled this country to produce the atomic bomb. Now, pioneering in another direction, Dr. Szilard is calling for a nationwide Council for Abolishing War, an organization that could spend twenty-five million dollars a year lobbying in the cause of peace.

In a recent address at the University of Chicago, the eminent biophysicist declared that without drastic political changes, the world is "headed toward an all-out war." One of the ways to avoid this disaster, he said, would be to create the organization he described.

Most importantly, the "movement to abolish war" would ask all those who joined it to contribute two per cent of their total income. Starting with a base of 50,000 students, Dr. Szilard estimated that the movement could reach 500,000 members in a year, which would raise a fund of fifty million dollars. The Council would use every form of personal and group lobbying to influence politicians, editors, columnists, television commentators and all those who influence public opinion. It would also contribute directly to political campaigns and "deliver the votes" of its members, who would promise to vote solely on the issue of "war and peace." It would be, said Dr. Szilard, "the most powerful lobby that ever hit Washington."

Dr. Szilard's idea is exciting and impressive. What is perhaps most notable about it is its rare combination of idealism and hard practicality, which is of course the essential combination. On the one hand, the plan envisaged by Dr. Szilard is single-minded and uncompromising in its idealistic objective of peace; on the other, it calls for hard, politically sophisticated action in the achievement of that objective.

On this score we think that Dr. Szilard is entirely right. The cause of peace is certainly of desperate importance today, and yet it has nothing like the immense pressure apparatus maintained at our government centers by dozens of special-interest groups. If peace has this vital importance, why should its cause not be supported as diligently and as effectively as the cause of the medical associations, or war veterans, or trucking interests?

We hope that Dr. Szilard is right in believing that his movement will attract millions of Americans, especially young people. Certainly it is a movement which offers youth today a need, a cause and a program. For the sake of all mankind, may it be a success, and may Dr. Szilard's greatest claim to fame—he has many—be that he fathered this inspiring plan to advance the cause of peace.

[redacted] THE COMMONWEAL

SAN FRANCISCO, CALIF.
NEWS-CALL BULLETIN
D. 200,492 SAT. 174 684
JAN 10 1962

Atom Age's 'Father' Lobbies Against War

LEO SZILARD, physicist, inventor, and author who has as much claim as anyone to the title "Father of the Atom Age," is in the Bay Area drumming up interest in a nationwide lobby of students, scholars, and scientists to influence U. S. policy toward the abolition of war. He spoke yesterday noon on UC's Berkeley campus. Today he meets informally with UC students for a two-hour bull session. Tonight he speaks at Stanford (7:30 o'clock, Cubberley Auditorium). Tomorrow he'll take on Stanford students in another question-and-answer session.

He has already carried on similar activities at the University of Chicago, Harvard, Swarthmore and Western Reserve. He plans to go from here to Reed College and the University of Oregon.

His object: To create a "lobby on behalf of reason," to influence Congress and the President to modify U. S. policy where he thinks it's leading down the road to war, to lend support to a scientific Council for a Liveable World.

Szilard speaks pessimistically but not despairingly. He feels all-out, world-destroying nuclear war is probable but not inevitable. He tells the students:

"Those of you who have watched closely the course of events in the past six months may have been led to conclude that we are headed for an all-out war.

"I myself believe that we are, and that our chances of getting through the next 10 years without war are slim.

"I find myself in rebellion against the fate that history seems to have in store for us, I suspect some of you may be equally rebellious.

"What can you do?"

What they can do, he says, is make a major, organized effort to influence U. S. behavior vis-a-vis the Russians.

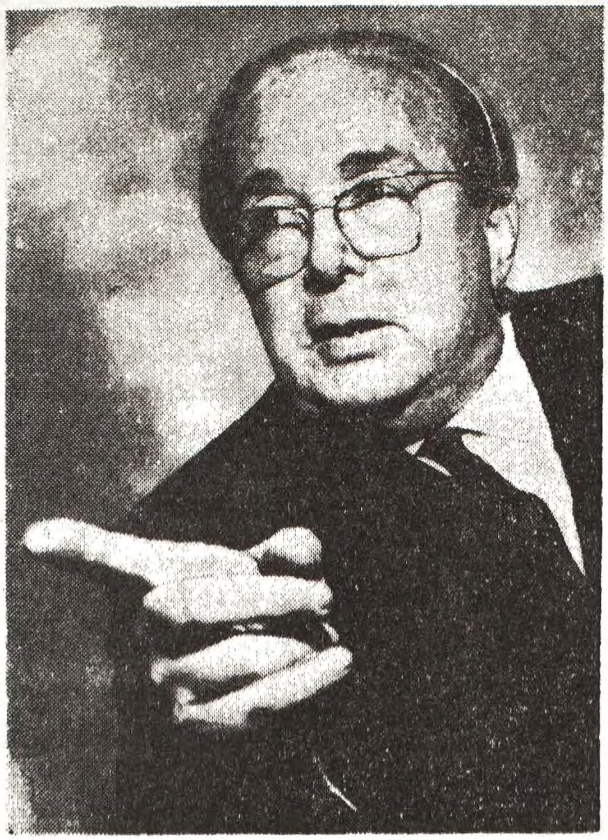
"You are not in a position to influence the Russian government; you will have to bring about a change in the attitude of the American government, which in turn may bring about a similar change in the attitude of the Russian government."

He says there are people inside Russia who are similarly frightened and similarly aware of the need for a fresh view and a fresh start. He suggests a U. S. movement to introduce "the sweet voice of reason" into international affairs would be welcomed by these Russians, would hearten them in their own efforts to avoid all-out nuclear war.

"It is conceivable that if a dedicated minority were to take effective political action, they could bring about the change in attitude that is needed," says Szilard.

Such a minority can exist and function only if it can agree on a set of political objectives, he says. He proposes these:

- America will not bomb Russian cities or bases unless U. S. cities or bases are bombed. In short, "we abandon first strike if necessary as national policy."
- German and U. S. extremists will call this appeasement or defeatism, Szilard concedes, but he argues victory in a nuclear war is no longer possible—we can at most hope only to exact a price for aggression.
- America will give no bombs to NATO or NATO countries, especially Germany. It is German possession of the bomb which the Russians, who lost 20 million to Nazi Germany in World War II, regard as the greatest threat to their security, Szilard agrees.
- America should proclaim that even if war comes and even if atom bombs are used, we will not use them against the Russians in their country, but only against invading troops on our side of the pre-war boundary.



SCIENTIST LEO SZILARD
A $20 million popular lobby is his goal

A National Lobby

'A People's Plan' To End Arms Race

'A People's Plan to End Arms Race'

By David Perlman
Science Correspondent

Leo Szilard, the Hungarian-born physicist who helped to forge America's first atom bomb, called for a national campaign to end the nuclear arms race yesterday.

He suggested a great popular lobby, led by scientists and financed by at least $20 million, to push for a binding American pledge against any use of nuclear weapons except in defense or retaliation against an atomic attack.

He announced that he is pressing his effort to launch such a lobby on campuses all over the country.

A LOBBY

His speech, delivered before a large crowd at the University of California's Wheeler Hall in Berkeley, drew an enthusiastic response from students and faculty members.

Szilard has been lobbying on his own and through scientific organizations for years —proposing new methods of slowing down the arms race, and new strategies for defensive action.

His concern, apparently,

From Page 1

dates at least as far back as the time in 1939 when he first conceived the atomic chain reaction and enlisted Albert Einstein's efforts to persuade President Franklin D. Roosevelt that the atomic bomb could become a reality.

He helped build that bomb, but opposed its use against Japanese cities. He has opposed nuclear war since.

PESSIMISTIC

Yesterday in Berkeley Szilard conceded he now believes "we are headed for an all-out war," and that "our chances of getting through the next ten years without war are slim."

But he insisted there is still a chance that a massive minority lobby, armed with "the sweet voice of reason and ten per cent of the votes, and the ability to make substantial political contributions," might stave off war.

CHANGES

Szilard's lobby, financed by firmly pledged gifts of 2 per cent of every adherent's income, would press the administration for these two unilateral declarations:

First, that the U.S. would in no circumstances launch strategic bombing of Soviet cities or bases except in retaliation for a bomb attack on America or an unprovoked attack on an American ally.

Second, that America would use tactical atom bombs against troops in combat only to counter an attack on America's own side of a pre-war boundary.

LIMITATION

Even unilaterally, Szilard said, this policy might well work to limit war if a conflict broke out: for it would virtually force Russia's tacit compliance under the threat of instant and devastating escalation of the war into "mutual murder and suicide."

Right now, Szilard argued, the threat of strategic "first strikes" amounts to just such a murder-and-suicide threat.

Thus, while force is still possible, true victory is no longer possible in the context of nuclear war, he said. Deterrence is obsolete.

RACE

"A first-strike-if-necessary policy," Szilard argued, "would mean an atomic arms race with the sky as the limit. I do not believe that America could be made secure by trying to keep ahead in such an arms race."

Szilard said America today has no choice but to maintain a small but effective atomic striking force in invulnerable bases, as "protection" and to make "conquest difficult, dangerous and expensive."

While this attempt to introduce a temporary and restraining stability into the present war-prone situation continues, Szilard said, other measures are in order.

SAN FRANCISCO, CALIF.
NEWS-CALL BULLETIN
D. 200 492 SAT 174 684

JAN 11 1962

Arthur CAYLOR

Just 10 Years Left

First, let me tell you what manner of man is Leo Szilard—a genius without an ivory tower whose many-sidedness gives him the capacity to accomplish anything. Already he has covered a lot of territory in that direction.

Then I'll try to give you some notion of the mission which brings him, a current visitor, to the college campuses of the Bay Area. It merely embraces the fate of the world and the rule of America. And when I say that, Junior, believe me I kid you not.

As a scientist, Szilard (with Enrico Fermi) proved you get more neutrons out of an atomic explosion than you put in. This is the basis of chain reaction—the thing that puts the boom in atomic bombs. It doesn't do him much good, but on this Szilard actually holds a patent.

Thus he's the father of the Atomic Age—at least the co-father. Similarly, he's the father of atomic warfare. He's the associate who got Einstein to urge Roosevelt to start Manhattan Project. Actually Szilard wrote the letter to the President. Einstein merely signed it.

Political Action for Survival

The purpose of Szilard's mission here has been well publicized. He seeks to keep the world from being suddenly atomized into Kingdom Come. The mission itself, however, has received scant attention. It likewise is merely epochal.

Szilard is out to learn whether the college communities of this country can be formed into a political-action group with sufficient wham to take charge.

In Japan, in Latin America, in Europe, in most other countries, college students have recently been mixed up in a big way in many political crises. But, so far, this has never happened here.

Szilard has picked UC, Stanford, Reed College, the University of Oregon, Harvard, Swarthmore, Western Reserve and his own University of Chicago to make what he calls "an experiment."

On each campus he is making speeches and holding bull sessions—very high level bull, naturally—to interest college students and faculty members in sampling opinion (including their own).

He's asking them to let him know within six weeks how many people they've contacted seem sufficiently interested in his program—after subjecting it to some thought—to give all-out support to such a movement. Names and addresses, please. And just people who can be counted on.

Awake, Students, Awake

"If thits experiment indicates such a movement could get off the ground," run the instructions, "then perhaps one would want to start The Movement with talks in front of large student audiences across the country, from coast to coast.

"If within the next 12 months, one could find 20,000 students who would go all out in support of the movement, and if each student would bring 10 other people into The Movement, then The Movement would rapidly attain 200,000 members.

"This would represent about $20 million per year in political contributions, or $80 million for a four-year period, and this is probably as much as one would want to have."

Szilard, I hope you know, thinks there's small chance of the world surviving the next 10 years unless both sides cool off. Since we can't modify Russian policy except, maybe, by example, the only alternative is to change American policy in the direction of a less warlike stance.

This change would be impressed on Congress and the President by a "lobby on behalf of reason" financed by The Movement. I quote the amounts which theoretically the lobby would have to spend to show you there's nothing chintzy about Szilard's concept. You wouldn't expect the inventor of the atom bomb to think small.

And there's no nonsense about Szilard's attitude toward the whole thing. He believes a dedicated minority could swing national policy. One certainly does in the Communist countries. But members have to be dedicated enough to put up their money as well as their moral support—say 2 pct. of their incomes.

Politics Over Science

There's no nonsense about the way the lobby would act, either. It wouldn't hesitate, for instance, to silence some irritating blabbermouth of the opposition by hiring him at $100,000 a year to keep his big mouth shut. On a smaller scale, such strategy has been common to practical politics for years.

If you're inclined to shrug off the whole deal as the vaporizings of a professorial crackpot, you couldn't be wronger. In the field of science you must accept Szilard as real big—perhaps the biggest.

Yet he's turning his back on science because he now sees politics as the dominating force in the world. It's a decision reached after a touch of cancer alerted a great mind to make the most of its remaining years.

Reporter (Portland Oregon)

A-Scientist Offers Formula to Avoid Hot War

By JACK ROBERTS

Leo Szilard is grandfather of the atom bomb, and this fact bothers his conscience.

So much so that he has spent considerable time and effort in exploring methods of halting, or slowing the arms race between East and West, which he predicts holds a 90 per cent chance of war in the coming 10 years.

Szilard spoke at Reed college Friday night, proposing a "movement" to influence our country away from the triggers of war.

"I am convinced that if we go to war to achieve victory, then atomic war is inevitable, but if we go to war prepared to resist and only to resist then war can remain limited," he said.

Szilard proposes a "movement" of voters who would take one-sided steps that he says would lead to relaxing tensions between Russia and the United States. Those steps:

". . . America should proclaim that she would not resort to any strategic bombing of cities or bases except if American cities or bases are attacked with bombs, or if there is an unprovoked attack with bombs on cities or bases of one of America's allies . . . America could and should proclaim that if, in case of war, she were to use atomic bombs against troops in combat, she would do so only on her own side of the pre-war boundary.

"America could and should resolve that atomic bombs and the means suitable for their delivery . . . shall remain in the hands of American military units which are under American command rather than be placed under the control of NATO."

PETE LIDDELL PHOTO

■ Dr. Leo Szilard, nuclear physicist whose discoveries led to atom bomb, suggests unilateral declaration of "resistance-only" use of bomb should war come.

Dr. Szilard said he is convinced such steps — almost equivalent to a promise not to use atomic weapons aggressively, or perpetrate a "first strike" in a so-called preventative war — would lead to some similar Soviet reaction, tending to ease the Cold War tensions.

He said the Russians "knew very well" that America is not ready to contemplate general disarmament now, and he said this may explain Soviet intrasigence on a number of disputed issues. He added:

"The Soviet Union's attitude might change overnight, however, if it became apparent that America was becoming seriously interested in disarmament."

Szilard proposes forming a "movement" of voters that would contribute 2 per cent of its income to what he calls a "lobby" to support candidates and issues that would lead to an end to the arms race.

Szilard spoke at Botsford auditorium Friday night, and again Saturday at the Reed faculty lounge. From here he goes to Eugene to speak to students at the University of Oregon. He is accompanied by his wife, an M.D., who, he said "is my doctor."

Szilard is a native of Hungary, is 64, and a famous physicist. He, with Enrico Fermi, originated the method of arranging graphite and uranium, which made possible the first self-sustaining nuclear reactor in 1942 and led to development of the A-bomb.

He and Eugene Wigner visited Albert Einstein in 1939, and Einstein wrote to Pres. Roosevelt and initiated federal support of atomic energy.

Szilard became a United States citizen in 1943, and in 1945 assumed leadership of a group of scientists opposed to dropping atomic bombs on Japanese cities.

He is currently working in molecular biology and is professor of biophysics at the University of Chicago.

Atomic Pioneer Bares Peace Plan

Atomic pioneer Leo Szilard, who believes the world as we know it won't survive until the year 2000 unless a solution is reached on the disarmament question, came to Portland Friday to discuss his plan to form a "Council for Abolishing War."

The short, pudgy Szilard, who discovered one method of creating the atom bomb, spoke at Reed College Friday evening, was to speak there again Saturday morning and at the University of Oregon Monday. Actually, he is proposing an experiment in speeches at selected colleges around the country to determine whether the "movement" he has formulated is wanted.

HIS MOVEMENT, in essence, includes the following ideas:

Ask 7 to 12 scientists to form the "Council for Abolishing War" or the "Council for a Livable World." It would assemble a panel of political advisers and work to formulate two sets of objectives.

To the first set belong objectives which cannot be attained at the present time through political action because research is needed to know what must be done. The second set includes objectives which can be pursued through political action.

Hearings would be held each four months to proclaim immediate objectives the movement would support. These objectives would be communicated to news media, congressmen and others.

MEMBERS of the movement would be expected to pledge 2 per cent of their income on political contributions which would go toward support of the objectives.

Szilard hopes that the movement would be able to state with certainty how many votes it represents on a political objective, in total and in each state and congressional district.

He reported that student response to the plan at both Harvard and the University of Chicago was overwhelming and that in both places about 100 students said they would participate in the experiment. He added that they also were agreeable to devoting 2 per cent of their income to political contributions with the money placed where it would be most effective.

SZILARD is frank to admit that he does not know whether this plan will result in abolishment of war, but he adds that something must be done. "We don't have 25 years to disarm."

He does not believe all mankind will perish in a nuclear war, but he foresees that America postwar would resemble America less than Russia resembles America today. He said the war would mean an end to our set of values.

He is the father of the "mined cities" concept to avoid all-out nuclear catastrophe. Countries would settle war-provoking quarrels by threatening to demolish a specified number of each other's cities on a one-for-one basis after residents had been evacuated. In this way, each country could save face and exact a price.

COUNCIL for abolishing war is advocated by atomic scientist Leo Szilard who's in Portland to find if such a council can win support. World won't survive until 2000, he says, unless nations disarm.

The Oregon Journal, Jan 13, 1962

Nuclear Expert Says World Rolling Along On Road To War

THE OREGONIAN, SATURDAY, JANUARY 13, 1962

"Are we on the road to war?," Dr. Leo Szilard, co-father of nuclear fission, asked a Reed College audience Friday night.

His answer is a coldly scientific "yes." The road is a short one that may well end in oblivion, at least for the United States and Russia, if not for the world, he says.

"We are headed for an all-out war. . .Our chances of getting through the next 10 years without war are slim," he declared.

"The chances of disaster are about 90 per cent," he said in a press conference. "But I would much rather concentrate on the 10 per cent chance of achieving peace."

Dr. Szilard, in fact, has laid aside his scientific career and given over his genius to what he modestly calls "an experiment" to determine whether a movement — not a new party —can be organized to support what might be called "A Lobby for Sweet Reason."

No 'Party' Planned

Dr. Szilard emphasized he was not attempting to organize a new political party, but a "movement" with supporters willing to contribute of their time and effort, plus two per cent of their income.

He is not attempting at this time to enlist anyone in this movement, but to determine whether such a movement can be successfully launched. He appealed to his Reed College audience, mainly college students, but not limited to students, "to look into your own heart and try to discover whether you would want to participate, provided the objectives appealed to you and you thought the movement could be effective."

He urged his listeners to discuss the proposed movement with others in their home communities and write him their reactions "in four to six weeks". "With luck we might be in a position to know within two months whether a movement of this kind can get off the ground," he said.

He envisaged 20,000 students spearheading a movement to gain 200,000 supporters to contribute $20 million a year for political action in directions to be determined by the "Council for A Livable World" which would govern the movement.

Scientists On Council

Dr. Szilard proposed to ask seven to 12 distinguished scientists to form the council, which would assemble a panel of political advisers to determine an immediate set of objectives designed "to back off from the imminent possibility of war." A research program would be undertaken to determine a long range set of objectives to achieve a stable peace.

A further question and answer program by Dr. Szilard is scheduled for 10 a.m. Saturday at Reed College, open to the public without charge.

DR. LEO SZILARD, co-father of nuclear fission, in Portland to pursue a new experiment in an effort to avert "the nuclear annihilation for which we are heading."

Dr. Szilard has been active in the governmental as well as the scientific arena, ever since he and Enrico Fermi obtained the first atomic reactor plant. The letter which Albert Einstein wrote to President Roosevelt Aug. 2, 1939 — which led to the Manhattan Project and the development of the A bomb — was based on the work of Szilard and Fermi.

In 1945 Szilard became the leader of the atomic scientists who opposed dropping atomic bombs on Japanese cities. In 1946 he shifted his interest to molecular biology. Last year he published "The Voice of the Dolphins," a group of five politico-scientific satires which subtly proposed a program for arms control and a stable world peace, all in the guise of fiction.

Dr. Szilard does not propose a platform for his movement, but he did float some of the following planks on the troubled seas:

The threat of atomic annihilation "can be solved only by abolishing war." This cannot be done by disarmament in the usual sense, but by "arms control," each country retaining force to retaliate but not to strike first. China would have to be included in such an agreement.

America should proclaim that she would not resort to strategic bombing unless American or allied cities or bases were bombed. She would not use atomic weapons except on her own or allied soil in a defensive action.

"American tourists should not be given spying assignments. . .We are losing more than we are gaining by trying to use them as spies."

The best hope of arms control is the great economic gains that both sides would make if relieved of the cost of armaments.

Dr. Szilard launched his experiment Jan. 9 in a speaking tour that included Harvard University, Swarthmore College, Western Reserve University, the University of Chicago, Reed, and will include the University of Oregon at 3 p.m. Monday.

Expert Says Use Of Nuclear Weapons 'Inevitable' If Victory U.S. Goal

Dr. Leo Szilard, co-father of nuclear fission, displayed wit as sharp as his wisdom in an interview during his Portland appearances at Reed College Friday and Saturday.

He is neither Republican nor Democrat "because I deal in truths, and truth has no place in politics," the atomic genius explained.

"The prospect of nuclear annihilation is too serious to be taken seriously," he wisecracked.

"There are some foolish people, both in Russia and America, who aren't afraid."

Dr. Szilard is not one of them. He doesn't expect to survive the next ten years unless the present head-on collision between the U.S. and Russia can be reversed.

The neutron bomb, which would kill people without damaging cities, is the least of his fears, however.

"This weapon is technically possible, but would be difficult to build and expensive," he explained.

Weapons in existence are sufficient to wipe out the U.S. and the U.S.S.R., "although there is hope Europe might survive," Dr. Szilard said in answer to questions.

Dr. Szilard, who holds the first American patents on an atomic reactor and inspired Dr. Albert Einstein's letter of Aug. 2, 1939, which led to the development of the A-bomb, sees no means of limiting a major war to conventional weapons.

"Atomic war is inevitable, if we want to win," he explained. "We cannot win by conventional arms. Once we introduce nuclear weapons, Russia will use nuclear weapons."

Dr. Szilard has no confidence in those who advocate building up our nuclear strength to ward off Russian attack on the assumption that given five years without nuclear war we could build up our conventional strength in Europe to compare with that of Russia.

He also "finds it hard to believe" that Russia really has only 50 long-range hydrogen missiles ready to fire at the U.S.

"They fired five in the recent tests. It is hard to believe they would fire one out of ten of their stock on hand," he indicated.

Test Not For Bang

He believes the Reds didn't detonate their 50-megaton bomb "just to hear it go bang." This is the weapon they would use as an anti-missile missile, Dr. Szilard believes. But he has little faith in anti-missile missiles, even if we succeeded in developing such a successful missile.

"It is not possible to make America secure in this kind of an arms race," he told the press.

"We have a 10-per-cent margin of hope at the present rate, but that is much more pleasant to contemplate than the 90 per cent chance of annihilation," he said.

Asked if he planned a bomb shelter for himself and his wife, also a doctor — of medicine — Dr. Szilard said he wasn't interested "in that kind of survival," although he felt the current fallout shelter program had aroused the nation somewhat to the seriousness of the situation.

Our nuclear weapons, no matter how much they might outnumber Russia's weapons are not "convincing" because no one, least of all Americans, believe that we would strike first, and the first strike could be the last, Dr. Szilard indicated.

'Mining' Suggested

If we did win a temporary victory, as we did after World War II, we would waste the victory, Dr. Szilard declared. "There is no market for wisdom in Washington. There is no indication we would mobilize enough wisdom to make use of any peace we might win in a war." he said.

The "Mined Cities" suggested by Dr. Szilard in an article in the current issue of the Bulletin of Atomic Scientists, is no mere fantasy, he said. It would be technically possible today for the U.S. to place hydrogen "mines" deep under 20 Russian cities, at the same time the USSR put hydrogen bombs deep under 20 similar American cities as a joint guarantee of peace, he said. Each could be fired only for retaliation against attack, he explains.

He believes the Russians want peace, under a system of arms control which gives each side a guarantee against the other. Most convincing argument for controlled disarmament to the Russians is the tremendous economic savings that could be achieved, he said.

Dr. Szilard Saturday answered questions about a Peace movement he has proposed. He said it would not be a membership organization but an assembly of people to show the world a "fresh concern" for peace.

He will speak at University of Oregon at 3 p.m. Monday.

Eugene Register-Guard

LANE COUNTY'S HOME NEWSPAPER

Eugene, Oregon, Monday, January 15, 1962

'Council for a Liveable World' Suggested

Scientist Urges Policy Changes to Avert All-Out War

By RALPH OLIVE
Of the Register-Guard

Leo Szilard, scientist, speaker and writer, is convinced the world is moving toward an all-out war in the next 10 years—unless the present political course is changed.

Szilard believes war can be prevented, if the governments of the United States and the Soviet Union change their attitudes. He is now conducting a campaign that may bring about such changes.

These views were expressed by Szilard Sunday afternoon, during an interview in Eugene, and again Monday afternoon at the University of Oregon, where he delivered a Failing Distinguished Lecture on the topic "Are We on the Road to War?"

In a speech prepared for delivery Monday afternoon, Szilard said "It has been apparent ever since the end of the war that the bomb would pose a problem to the world for which there is no precedent and which cannot be solved short of abolishing war."

The 63-year-old Szilard, who was educated at the Budapest Institute of Technology and the University of Berlin, came to the United States in 1938. In the middle-thirties, Szilard conducted experiments in nuclear physics, and later worked with Enrico Fermi at Columbia University, devising the chain reaction system. In 1946, Szilard turned to a new field, molecular biology, at the University of Chicago. He is still a member of the Chicago faculty.

LEO SZILARD
Campaigning for Changes

To prevent war, Szilard has proposed a set of political objectives, and formation of a council to carry out the objectives.

Szilard has proposed that the U.S. government make "unilaterally, two crucially important policy decisions":

- The proclamation that Amireca will not resort to any strategic bombing of cities or bases, either by means of atomic bombs or conventional explosives, except if American cities or bases are attacked with bombs, or if there is an unprovoked attack with bombs on cities or bases of one of America's allies.
- America should proclaim that, in case of war, if "she were to use atomic bombs against troops in combat, she would do so only on her own side of the pre-war boundary."

This last point must be considered in the framework of what an atomic war will mean, Szilard said — "That today it might still be possible to resist force with force, but the objective of the use of force can no longer be victory. The objective can only be to exact a price.

"As long as force is used at all, an all-out war which neither side wants, can be avoided only if both sides recognize that the use of force must not be aimed at victory, or anything approaching victory."

Szilard also believes that any atomic weapons stationed in Europe should remain under American command, rather than under the control of NATO.

"As long as we are committed to defend Western Europe," he said, "there is no valid argument for turning over bombs to the control of other Western European nations."

Another step toward peace, Szilard said, would be a policy decision to stop fighting "meaningless battles in the cold war."

To bring these and other goals to realization, Szilard has suggested formation of a "Council for a Liveable World," composed of seven to twelve distinguished scientists.

The council would assemble a panel of political advisers, and together they would formulate two sets of political objectives—the first would be long range, requiring further inquiry and research. The second set, Szilard explained, "can be pursued through political action, because it is clear what needs to be done."

He indicated that specific goals would be formed, but basically would concern the proposals above that Szilard has outlined to help abolish war.

Supporters of the council's proposals would be asked to spend 2 per cent of their income on political contributions. They would also be asked to vote for and work for the objectives, and in this sense would be considered members of the movement.

Immediate goals could be sought through a lobby, Szilard said.

"One of the main functions of the lobby," he said, "would be to help the members of the movement clarify their own minds on the political objectives they wish actively to support, and to help arrange appointments for those members who come to Washington to see congressmen, senators and certain key members of the administration."

Szilard has spoken at several colleges and universities, explaining his ideas. He asks those who are interested to contact him, let him know of their interest, and of that of others in the community.

"If enough of you collaborate in this experiment," he said, "with luck we might be in a position to know within two months whether a movement of the kind I have described would get off the ground." (See Story Page 3A)

THE STANFORD DAILY

EDITORIALS • COLUMNS • REVIEWS

Owned and published daily except Saturday and Sunday by the Associated Students of Stanford University. Represented for national advertising by National Advertising Service, Inc., San Francisco; 18 East 50th St., New York. Entered as second-class matter at the post office at Palo Alto, Calif., under the Act of March 3, 1879.

Subscriber: United Press International Subscriptions: $2.50 a quarter; $7.00 a year

JERRY RANKIN
Editor

MARGE HARDING
Managing Editor

JERRY DOBSON
Business Manager

CAMPUS OPINION

Szilard Suggests a New Plan of Political Action

By WILLIAM B. WOOD

"I believe that our chances of getting through the next 10 years without war are slim," Leo Szilard told his Stanford audience last Wednesday night. "I find myself in rebellion against the fate that history seems to have in store for us, and I suspect that some of you may be equally rebellious. The question is, what can you do?"

Confronted with the political power of the various interest groups who favor increasing armaments and civil defense measures, concerned individuals throughout the country have long been troubled by this question. Lack of an answer has led to a general feeling of helplessness and a resort to demonstrations, marches and other forms of passive dissent, negative reactions whose principal effect has been only to equate desire for peace with suspicious political leanings in the minds of a few irrational patriots.

Szilard, in answer to the above question, proposes a plan for positive action which would, for the first time, unite the scattered scientists, academicians, and concerned individuals "who see current events in their historical perspective" into an effective political movement, dedicated to terminating the unlimited arms race, instituting a workable agreement on arms control and eventually removing entirely the danger of an unwanted atomic war.

POLITICAL CONTRIBUTIONS from members pledging a small percentage of their yearly income would provide the means to operate a lobby or pressure group in Washington in pursuit of the movement's immediate political objectives. These would be formulated by a council of scientists, a board of political advisers and a research organization. Through these various groups, the movement could provide to members of the administration not only informed opinions, but also tangible support in the form of votes and funds for political action.

Such a program would not only be highly desirable, but might also be feasible and quite successful. Feasible, because Szilard is not seeking to convert anyone; he wishes merely to provide an opportunity to be heard and felt in Washington for those who already share his convictions. He believes that an effective program could be set up with the dedicated support of only one hundred to two hundred thousand contributing individuals. Successful, because it would operate politically, at the level of the federal government where policy decisions are made, and in a manner which has proven to be one of the most effective in getting results out of our administrative machinery.

If Szilard's program is instituted, he will become, at most, no more than a member of the scientists' council. Enthusiasm for his plan therefore by no means requires agreement with all of his opinions and personally favored political objectives. These, regardless of their merit, should not be allowed to divert attention from his most important and immediate aim: that of giving a place and a voice in Washington to a concerned minority of Americans who up to now have had little success in halting our steady progress toward an atomic clash.

Szilard points out that the chances for a controlled disarmament will rapidly diminish as possession of nuclear weapons becomes more widespread. He has a sincere conviction that this minority must waste no time in making itself heard.

IN ADDITION, he appears to have a practical plan by which it might do so, and the contacts in Washington to put the plan into effect. His program could lead to tangible results which will never be achieved by all-night vigils in public places or marches across continents. It is a first opportunity for concerned individuals in this university and across the country to initiate positive action which might eventually save us from a nuclear catastrophe. This plan deserves now, in its experimental stage, the strong support of the Stanford community.

(NOTE: For those who did not hear Szilard's speech, he is now in the process of conducting an "experiment" in a few selected university communities, urging interested students to assist him by contacting adult members of the community during the next few weeks and sending the names of those who wish to pledge support of the program to Leo Szilard, Hotel Dupont Plaza, Washington 6, D.C. From the magnitude of the response, he hopes to estimate how soon and to what extent his plan could be put into effect. Additional information and copies of his Wednesday night speech can be obtained by writing to this address.)

BOSTON, MASS.
CHRISTIAN SCIENCE MONITOR
D. 156,267

JAN 24 1962

Szilard Stumps for Strong Peace Movement

By John C. Waugh
Staff Correspondent of The Christian Science Monitor

Los Angeles

Another distinguished physical scientist is addressing the issues of war and peace.

He is Leo Szilard, the noted biophysicist and pioneer in the development of the atomic bomb. And he is more than just "addressing" the subject.

In talks around the country he is conducting an "experiment" which he hopes will lead ultimately to political action of a major magnitude. The practical applications he envisions for his "experiment" will be to exert a force strong enough in United States politics to reverse the policies of nations which he sees now leading inevitably toward war.

Dr. Szilard, who drafted the famous letter the late Albert Einstein sent to President Franklin D. Roosevelt on the feasibility of an atomic bomb,

Dr. Leo Szilard
First the A-bomb, then peace

has turned all his energies to this end. He hopes soon to establish first a "Council for Abolishing War" and ultimately a vigorous and effective national lobby for peace.

Started at Harvard

He began his crusade with a speech at Harvard in November. He has since spoken at colleges around the country, including his own University of Chicago (he has been on leave from that institution's Enrico Fermi Institute for Nuclear Studies).

He has just articulated his ideas in a Los Angeles speech sponsored by the Committee for a Sane Nuclear Policy. He will continue speaking on the subject through February, mostly on college campuses.

Dr. Szilard's plan, in brief, is this:

First, through his speechmaking across the land he hopes to formulate tentatively a "set of political objectives on which reasonable people — those with a perspective of history — could generally agree."

If he sees that he can stir enough support he will form his council, to be composed of seven to 12 distinguished physical scientists. It will be called the "Council for Abolishing War," or perhaps the "Council for a Liveable World."

Procedure Outlined

It, in turn, would assemble a panel of political advisors and together they would formulate two sets of objectives. The first of these would be to instigate a program of research and study on long-range aims, those not yet possessing clear courses of action, hence not yet attainable through political action.

The second set of objectives would be those whose solutions are more obvious and hence can be pursued now through political action.

To attain the first objective the council would form a research organization. To attain the second, it would establish its "peace lobby."

Target Set

Dr. Szilard, in a press conference here, indicated that the lobby would not be formed until the number of enlistees in the movement—he prefers to call it a movement, not an organization—has grown to about 200,000, all willing to commit at least two per cent of their incomes to the project.

With a financial base of about $25,000,000 a year, Dr. Szilard visualizes that this peace-seeking minority can become a powerful political force indeed, perhaps "the most powerful lobby ever to hit Washington."

Dr. Szilard says the lobby would address the issues of war and peace with "the sweet voice of reason," throwing itself actively behind goals it feels would lead to a resolution of world tensions and ultimately to total abolishment of war itself.

"War," Dr. Szilard said in his lecture here, "seems to be inevitable, unless it is possible somehow to alter the pattern of behavior which America and Russia are exhibiting at present.

"You, as Americans, are not in a position to influence the Russian Government; it follows that you would have to bring about a change in the attitude of the American Government which, in turn, may bring about a similar change in the attitude of the Russian Government.

"It is conceivable that if a dedicated minority were to take effective political action, they could bring about the change in attitude that is needed. But such a minority can take effective action only if it is possible to formulate a set of political objectives on which it can unite."

Policies Drafted

What are these objectives? Dr. Szilard articulates some of them:

- The United States, he reasons, should proclaim that it will not resort to any strategic bombing of cities or bases unless it or its allies are attacked first.
- The United States should further proclaim that in case of war it would employ atomic weapons only in the territory that is being defended.
- The United States should resolve that nuclear weapons and their means of delivery should remain in control of American military units under American command rather than put under NATO control.
- The President should issue an executive order against fighting "meaningless battles" in the cold war.
- The East-West cultural exchange must be improved and the Central Intelligence Agency be strictly refrained from approaching "those who go to Russia as tourists."
- Nongovernmental discussions between Americans and Soviets about how to secure peace in a disarmed world should be arranged, through private initiative, with the blessings of the administration, to help and prod nations toward disarmament.
- An influential private group is more fit than a governmental one in helping establish democracy in the underdeveloped nations and should be organized to do so.

Mabley's Report

Atom Expert's Plan to Avert All-Out War

BY JACK MABLEY

LEO SZILARD, PROFESSOR OF biophysics at the University of Chicago, is one of the brilliant band of atomic scientists who developed nuclear weapons in the early 40s, and since have been striving to avert use of these weapons in war.

JACK MABLEY

Szilard has a passion for truth which prevails over bias for his own nation, the United States. This enables him to see current events in historical perspective, and accounts for remarkable accuracy, by him and his fellows, in foretelling events which now are shaping the world.

Szilard recently said this to University of Chicago students:

"I myself believe that we are headed for an all-out war, and that our chances of getting thru the next 10 years without war are slim.

"I, personally, find myself in rebellion against the fate that history seems to have in store for us, and I suspect that some of you may be equally rebellious. The question is, what can you do?"

Szilard then proposes something that can be done. I strongly recommend it to those who ask that question, to those who despair, to those who already have turned away from these words because they fear and feel they are impotent in the face of this overwhelming problem.

• • •

LEADING UP TO HIS PROPOSAL, Szilard states:

"To abolish war is a tall order, and I speak of it with reluctance. It has been apparent, however, ever since the end of the war, that the bomb would pose a problem to the world for which there is no precedent and which cannot be solved short of abolishing war."

He calls the first objective the backing away from our closeness to all-out war. To cite how close we have come, he suggests that if America had openly intervened in Cuba, Russia would have moved into West Berlin.

If we can back away from seven minutes to midnight, says Szilard, the next objective would be to attack the basic causes of misunderstanding between the great nations.

Szilard proposes to set up a council of seven to 12 distinguished scientists, called a Council for Abolishing War or perhaps Council for a Livable World. This Council would assemble a panel of political advisers.

The Council also would set up a political organization. "Because one of the functions of this organizion would be to lobby, we may refer to it, for our purpose, as the Lobby," he said.

"The Council would speak with the sweet voice of reason, and our Lobby could see to it that they shall be heard by people inside the administration and also by the key people in Congress.

"Would they be listened to, if they were not able to deliver votes?

"The minority for which they speak might represent perhaps 10 per cent of the votes, and 10 per cent of the votes alone would not mean very much, just as the sweet voice of reason alone would not mean very much. Still, the combination of 10 per cent of the votes and the sweet voice of reason might turn out to be an effective combination."

• • •

THE MINORITY OF WHICH SZILARD speaks would be Americans who joined the Movement. They would support, by work and money, the Council and the Lobby.

This is a necessarily skimpy summary of Szilard's ideas. The copy of his talk to the students is 16 single-spaced pages. For those who would like the full story, there are copies still available for the asking. Mrs. Ruth Adams, 935 E. 60th st., Chicago 37, will mail a copy if you'll send her an addressed envelope with nine cents postage on it.

Szilard offered the idea at the Chicago, Harvard, Swarthmore, and Western Reserve college communities, and asked for reaction.

If the response is good, he will go ahead.

Whatever help he can use from this citizen, he will get.

[Mabley broadcasts nightly at 8 on WBBM.]

ASIMOV: Encyclopedia of Men + Women of Science

serves as the basis of modern er-forecasting.

y showed by 1920 that the atmos- is made up of "air masses" that more or less sharply differentiated perature between warm "tropical sses" and cold "polar air masses." arp boundaries between them they "fronts" from an analogy with the lines that had so impressed them on the minds of man during the ıst ended. During the 1920s and the manner in which the masses it out were analyzed.

1939 the younger Bjerknes came United States and the next year ed a professorial position at the rsity of California. He was natu- as an American citizen in 1946. nwhile, World War II occasioned meteorological discovery. Ameri- ombers, flying high across the on their way toward Japan, some- found themselves virtually motion- They had entered a stream of moving air, blowing from west . This was the "jet stream."

re are two of these, one in the rn hemisphere and one in the rn, at a height of from six to nine The usual velocity of the wind is 100 to 200 miles per hour, though of 350 miles and more have been ed. They make winding girdles the earth, following the paths be- the polar and tropical air masses herefore usually marking the re- of greatest storminess.

changing course of the jet streams day to day is now also taken into nt in plotting the movements of the asses and in attempting to predict events in the changing weather- n.

BLACKETT, Patrick Maynard Stuart
English physicist
Born: London, November 18, 1897

kett entered a naval school in at thirteen, to train as a naval . The outbreak of World War I

came just in time to make use of him and he was at sea throughout the war, taking part in the Battle of Jutland.

With the war over, however, he re- signed from the navy and went to Cam- bridge, where he studied under Ruther- ford [380]. It was Blackett who first turned to the wholesale use of the Wilson [372] cloud chamber. Rutherford had observed scintillation effects on a screen of zinc sulfide and had interpreted those as indicating that he had succeeded in converting nitrogen to oxygen through the bombardment of the former with alpha particles. Blackett felt the need for more direct evidence of this.

In the early 1920s, therefore, he went to work with the cloud chamber. He bombarded nitrogen within the cloud chamber with alpha particles and ex- panded the chamber periodically in order to catch any tracks that might be formed. He took over 20,000 photographs, catch- ing a total of more than 400,000 alpha particle tracks. Of these tracks, just eight involved a collision of an alpha particle and a nitrogen molecule. From the forked tracks that resulted, it was pos- sible to show that Rutherford's conten- tion that elements had been transmuted was correct. These first photographs of a nuclear reaction in progress, taken in 1925, were immensely impressive, and if anything was needed to dramatize the Wilson cloud chamber this was it.

Blackett turned the cloud chamber to other uses as the 1930s approached. He almost discovered the positron but Anderson [498] was a bit ahead of him there. He also studied cosmic rays, and here an idea struck him.

There was no way of knowing when an interesting event was taking place in the cloud chamber, so that the chamber had to be expanded at random and as often as possible in the hope of catching something. In 1931, therefore, Blackett placed a Wilson cloud chamber between two Geiger [380a] counters. Any cosmic ray particle passing through both Geiger counters had to pass through the cloud chamber. Blackett arranged the circuits so that the surge of current set up in the two counters operated the cloud chamber. In this case, the chance of a significant photograph in these "coinci- dence counters" was enormously in- creased.

In 1935 Blackett showed that gamma rays, on passing through lead, sometimes disappear, giving rise to a positron and an electron. This was the first clear-cut case of the conversion of energy into matter. This confirmed the famous $E=mc^2$ equation of Einstein [406] as precisely as did the more numerous ex- amples, earlier observed, of the con- version of matter to energy (and even more dramatically).

During World War II, Blackett worked on the development of radar and the atom bomb. After the war, however, he was one of those most vociferously concerned with the dangers of nuclear warfare. In 1948 he was awarded the Nobel Prize in physics for his work with and upon the Wilson cloud chamber.

[466] **SZILARD,** Leo (zee'lahrd)
Hungarian-American physicist
Born: Budapest, Hungary, Febru- ary 11, 1898
Died: La Jolla, California, May 30, 1964.

Szilard obtained his doctorate at the University of Berlin in 1922 and joined its faculty thereafter. When Hitler came to power, however, Szilard, mindful of his Jewish origins, lost no time in leav- ing Germany, and went to England.

While in England he went into the field of nuclear physics and in 1934 con- ceived the idea of a nuclear chain re- action, in which a neutron induced an atomic breakdown, releasing two neu- trons which break down two more atoms, and so on. He even applied for a patent for the process, keeping it secret, in part, because he foresaw its importance in nuclear bombs. However, the reaction he had in mind involved the breakdown of beryllium to helium and this did not, in fact, form a practical chain reaction.

Nevertheless, when uranium fission was discovered by Hahn [405] and an- nounced by Meitner [405a] in 1939, Szilard saw that here was a chain re- action that *would* be practical. He had

come to the United States in 1937 and now he realized the importance of getting a practical nuclear bomb before Hitler did. That summer, he and Wigner [466a], another Hungarian refugee, persuaded Einstein [406] to write his famous letter to President Franklin D. Roosevelt, and this set in motion the "Manhattan Engineer District" that was to prepare the first nuclear bomb.

Szilard worked with Fermi [482] in Chicago on the development of the first self-sustained nuclear reactor, their innovation being the use of graphite as a moderator to slow neutrons to a velocity where they were most efficiently captured. (The French, under Joliot-Curie [474], were trying to use heavy water for the purpose.)

In 1943 Szilard became an American citizen. Once the atomic bomb was ready for use, Szilard was one of the large group of scientists who, in revulsion at their own work, pleaded that the bomb not be used or else used only over uninhabited territory as a demonstration. The military, and some scientists such as Compton [450], thought otherwise, however, and President Harry S. Truman made the fateful decision that visited nuclear destruction upon the Japanese cities of Hiroshima and Nagasaki.

Szilard veered away from nuclear physics after the war, accepting a post as professor of biophysics at the University of Chicago in 1946. He has labored unceasingly to ban nuclear warfare and even nuclear testing and to turn nuclear power to peaceful uses only. In 1959 he received the Atoms for Peace award.

[466a] WIGNER, Eugene Paul. Hungarian-American physicist. *Born:* Budapest, Hungary, November 17, 1902.

Wigner was educated as a chemical engineer (he was a classmate of Neumann [491] in high school) and obtained his doctorate at the University of Berlin in 1925. He taught in Berlin and, until 1930, in Göttingen, where he worked with Hilbert [346]. In 1930 he was invited to the United States, where he obtained a position as professor of mathematical physics at Princeton University and became an American citizen in 1937. In 1936 Wigner (a brother-in-law of Dirac [485]) had worked out the theory of neutron absorption, a theory that proved useful indeed when it was time to build a nuclear reactor to make use of neutron absorption. He worked out the theory of conservation of parity which, two decades later, Lee [535] and Yang [535a] were to show did *not* apply in certain types of nuclear reaction. Wigner also showed that nuclear forces did not depend on electric charge, so that protons and neutrons within the nucleus had similar properties in that respect. This was a concept most useful to Yukawa's [509] meson theory. He worked with Szilard [466] to alert the American government to the need for developing a nuclear bomb, and then worked with Fermi [482] and Szilard in Chicago to develop one. He also helped design the atomic installations at Hanford, Washington. After the war, he was director of research at the Clinton Laboratories at Oak Ridge for a time. In 1960 he received the Atoms for Peace award and in 1963 shared the Nobel Prize in physics with Goeppert-Mayer [466b] and Jensen [466c].

[466b] GOEPPERT-MAYER, Marie (ger′pert-may′er). German-American physicist. *Born:* Kattowitz (now Katowice, Poland), June 28, 1906.

Marie Goeppert received her Ph.D. at the University of Göttingen in 1930, moved to the United States that same year, and became an American citizen in 1933. She married a physical chemist, Joseph Mayer, and, like Irène Curie [474a], used a hyphenated name thereafter. In 1945 she joined the staff of the University of Chicago and while there, in 1948, she suggested that the atomic nucleus consisted of protons and neutrons arranged in shells, as electrons were arranged in the outer atom. This theory made it possible to explain why some nuclei were more stable than

others, why some elements were
isotopes, and so on. At about t
time, Jensen [466c] advanced t
notion independently. Both she
sen accordingly shared the 196
Prize in physics with Wigner

[466c] JENSEN, J. Hans
German physicist. *Born*
burg, June 25, 1907.

Jensen obtained his Ph.D. at
versity of Hamburg in 1932 an
now director of the Institute fo
retical Physics at that university.
vanced the notion of nuclear s
dependently of Goeppert-Mayer
and in 1955 co-authored a book
subject with her. They shared t
Nobel Prize in physics with
[466a].

[467] **SCHOENHEIMER,**
(shern′high-mer)
German-American biochem
Born: Berlin, May 10, 18
Died: New York, New
September 11, 1941

Educated in Germany and
his Ph.D. at the University of
Schoenheimer was another of th
man scientists to whom the co
Hitler meant that safety lay only
He emigrated to the United St
obtained a position at Columbia
sity College of Physicians and S

In 1935 Schoenheimer introdu
use of isotopic tracers in biochem
search. Hevesy [422] had been
to make use of isotopes more
decade earlier, to be sure, but
worked with lead isotopes, at
types that were foreign to living
and isotope work had languishe
By 1935, however, deuterium, th
isotope of hydrogen, had becom
able in reasonable quantity, th
the work of Lewis [390] and Ure
Here was an isotope of an
naturally found in living tissue.

Schoenheimer made use of fa

Princeton University Press.

The Atomic Bomb and the End of World War II

BY HERBERT FEIS

Originally published in 1961 under the title *Japan Subdued: The Atomic Bomb and the End of the War in the Pacific*, now revised and made more complete and revealing.

PRINCETON NEW JERSEY
PRINCETON UNIVERSITY PRESS
1966

PAYMENT
COMPLETE
PARTIAL
FINAL

ish the following on th
uthority of 10 USC 230

nent agency or in accor

A GRAZIAN

MBER

ne end

nd added

AMOUNT V

S/R ACCOUNT NO.

STORAGE LOCATION

B/L NUMBER

SEE REVERSE SID

85 86 87 88 89 90 91 9

Form approved b
13 D

or relax those territorial claims he had staked out soon after Russia entered the war.

While discussions within the American government of our policies settled and subsided after this May 31-June 1 meeting of the Interim Committee, it flared up higher among some of the scientists who were well acquainted with the problems of atomic fission and who foresaw the enormous destructive power that could be conjured out of atoms. From what they learned of the program endorsed by the Interim Committee they were convinced that it was shortsighted, and morally and perhaps mortally wrong.

The asseverations of Bohr—and of Stimson when he wrote and spoke as preacher-statesman rather than as soldier—that the new discovery made it compulsory for nations to behave differently to each other than ever in the past, were flaming gospel in the studies and laboratories of many scientists. As the momentous event, the birth of the weapon, neared, they resounded louder and louder.

A group who had achieved much at the laboratories in Chicago, known by its cover name as the Metallurgical Institute, were among those most upset by what they learned about the trend of official planning, so disturbed that they might have been openly mutinous except for the clamps of secrecy and security. The group abhorred the thought that their work might destroy nations and envisioned the possibility that it might draw them together at last.

Knowing of the stew they were in and their clamorous wish to have their views considered, Arthur Compton had stepped forward and acted as liaison between them and officialdom.[37] On his return from Washington after the May 31-June 1 meeting, he assured the laboratory leaders that the Interim Committee was receptive to suggestions about all aspects of the future of atomic energy, and would be glad to be fully advised of them before its next meeting.[38] The Chicago scientists had thereupon formed several committees, each of which was to be concerned with an aspect or area of the field. One of these was the Committee on Social and Political Implications. Its chairman was an eminent chemist, Professor James O. Franck; its catalytic member was Professor Leo Szilard.[39]

One of the main authors of the memo presented by this committee to the government, Professor E. Rabinowitch, has recalled its origins and the flow of feeling that penetrated it. "I remember many hours spent walking up and down the Midway with Leo Szilard arguing about these questions [and] sleepless nights when I asked myself whether perhaps we should break through the walls of secrecy and get to the American people the feeling of what was to be done by their government and whether we approve it. . . . Franck started drafting the report but had difficulty because of the language, and turned over his notes to me. . . . The report was prepared essentially by me with the important contribution of Leo Szilard. . . . [He] was responsible for the whole emphasis on the problem of the use of the bomb which really gave the report its historical significance—the attempt to prevent the use of the bomb on Japan. While the authorship of the whole report was mine, the fundamental orientation was due above all to Leo Szilard and James Franck. . . ."[40]

Their eloquent charge still reverberates today. But the main features of its supporting argument are essentially the same as those in previous presentations of which we have told. The notion that the United States could protect itself for an indefinite time was dismissed as mistaken. For the basic facts and implications of nuclear power were common knowledge, and the experience of Russian scientists in nuclear research was sufficient

[37] *The New World*, pages 365-367.
[38] *Ibid.*, page 365.
[39] *Ibid.*
The seven members of this Committee were: James O. Franck as Chairman, Leo Szilard, T. R. Hogness, Donald Hughes, J. J. Nixon, E. Rabinowitch, Glenn Seaborg and J. C. Stearns.

Just before the San Francisco conference convened, Arthur Compton had taken Professor Franck of Chicago to see Vice President Henry Wallace. They expounded their views to Wallace and gave him a memo stating them, "Scientists found themselves in an intolerable situation. Military restrictions were tearing them between loyalty to their oaths of secrecy and their conscience as men and citizens. Statesmen who did not realize the atom had changed the world were laying futile plans for peace while scientists who knew the facts stood helplessly by."

Szilard, while working with Fermi at Columbia University in 1939-40, had been one of the persons who had persuaded Einstein that the American government ought to be examining the adaptation of atomic fission for military purposes, and induced Einstein to write a letter to President Roosevelt which, by calling attention to the military significance of recent scientific progress in fissuring the atom, helped to focus official interest on the field, which resulted in the Manhattan Project.

By the time that the bomb had been created and Germany was defeated and all danger that it might acquire this weapon was past, Szilard and his colleagues began to have misgivings about the introduction of this new and greater destructive force into warfare. So, before the meeting of the Interim Committee (May 31-June 1), he had gone down to South Carolina to see Byrnes who was Presidential representative on the Committee. He had spoken critically of the three scientist members of the Committee (Bush, Conant and Karl Compton) but well of the Scientific Panel. About this visit Byrnes subsequently wrote, "Szilard complained that he and some of his associates did not know enough about the policy of the government with regard to the use of the bomb. He felt that scientists, including himself, should discuss the matter with the Cabinet, which I did not feel desirable. His general demeanor and his desire to participate in policy making made an unfavorable impression on me. . . ." *All in One Lifetime*, page 284.

[40] Interview with a representative of the National Broadcasting Company for TV.

may 1963

THE FOREIGN PRESS IN REVIEW

A Scientist's Responsibility

(U.S. Atomic Scientists' Journal on War and Peace)

Y. VOLODIN

THE *Bulletin of the Atomic Scientists* published over the last 17 years by a group of Chicago scientists is not specially technical literature: it discusses primarily problems of social significance in contemporary, specifically atomic, science. Among the members of the Editorial Board and contributors to the journal are many who assisted at the birth of the atom bomb in the fond hope that it would somehow prove possible to avert the monstrous dangers attendant on its arrival into the world. Is this possible? How can this be achieved? What can and should scientists do? This is the prevalent theme of the *Bulletin* over the years. In this article we review its 1962 issues and No. 1 for 1963.

The journal's main policy line on these matters is quite definite. "... The development of science and technology ... make the fighting of a war irrational and suicidal for both sides—the stronger as well as the weaker, the righteous as well as the wicked.... The survival of both systems will depend on avoidance of war." These are the words of editor and foundation member of the *Bulletin* Eugene Rabinowitch, an American biophysicist associated with the Pugwash movement.

In assessing the standpoint of the *Bulletin,* it should at once be noted that, with all the diversity of thought of its individual contributors, they all share the fundamental illusions and prejudices of modern bourgeois liberalism. While they recognise and proclaim the need to maintain peace, they have at times a very hazy idea of how this may be done and often repeat versions of international events put out by reactionary propagandists. This cannot, of course, obscure the main point: a considerable section of America's atomic scientists and engineers are coming, each from his own starting point, by different paths, to the defence of peace and peaceful co-existence. The reason is that peace is a necessity for both Communists and non-Communists, materialists and idealists, supporters of Socialism and of bourgeois democracy.

It is not difficult to grasp who are the precise opponents against whom the *Bulletin* is waging a fight in each issue. They are America's "wild men", preachers of thermo-nuclear carnage, who are busy with plans for the physical "extermination" of Communism and are fobbing off their own people with myths about surviving a war with trifling losses. They are the notorious Senator Barry Goldwater who is still calling for victory in the cold war (he is answered by R. Fisher in the January issue of the *Bulletin,* who says: "Let us seek not to win a war but to achieve a peace"). They are the Air Force Association—that motley collection of retired generals and war merchants, a mouthpiece of the Pentagon—which demands the "complete eradication of the Soviet system" by means of a nuclear blow (see No. 2). They are General N. Twining, who dreams of the day when Soviet Russia will be bombed, General O. Anderson, who declares that he would be glad to bomb Russia—just give me the order to do it, he says.

Among their number is major scientist Edward Teller, one of the "fathers" of nuclear weapons, who long ago lent his name to propaganda for the atomic arms race. In 1962, he and co-author Allen Brown published a short book *Legacy of Hiroshima.* Their justification of the savage bombing of Japanese cities is only a prelude to justifying an even more savage "programme", the main points of which are: maximum increase of "nuclear deterrent" armaments; preparedness for "limited nuclear war"; boosting of the panic campaign around "civil defence" and, in the nature of an adornment, the slogan of world government.... In a review the sociologist Hans J. Morgenthau

---

Y. Volodin—Soviet journalist.

writes in No. 6 about the harmful character of this book, where, he says, modern scientific thought sits cheek by jowl with an outdated mode of military and political thinking.

The main argument advanced by the *Bulletin's* contributors against statements made by the "wild" militarists and their scientific advisers is that in our day the scientific and technical revolution has fundamentally altered the nature of war. While in the past attempts to resolve world conflicts by military means was possible and to that extent "rational", today this is impossible. As the *Bulletin's* editor observes, because of the revolution in military technique, "the conflict between the communist and the non-communist world has assumed its apocalyptic aspects". A similar view is expressed by guest contributor Bertrand Russell (No. 3). The conclusion is drawn that the main question at issue is not preparation for war but the search for ways of peaceful co-existence.

A good example of this approach is the *Bulletin's* reaction to the high pressured campaign on atomic shelters which was started in the United States in the autumn of 1961. This campaign served the "wild men" as a pretext for fostering war hysteria and for the most diverse kinds of profiteering and speculations—from financial to religious. A whole series of articles and letters in the *Bulletin* protested that this piece of trickery was dangerous not only because of its long-term consequences but because of its immediate effect on American society. "It is extremely dangerous to give the impression that the building of fallout shelters will enable the average citizen to survive a nuclear war," warns a group of scientists headed by J. Van Allen in a statement published in the January issue.

The following month Gerald Piel, editor of the *Scientific American,* contributed a long article on civil defence illusions. He noted that whereas shelters might save part of the population from radioactive fallout, they offered no protection from heat stroke, which was the greatest danger of the Hiroshima bomb. In this same issue there appeared, together with a cautious statement by the Federation of American Scientists against cheap publicity about shelters, a letter from a group of Boston scientists to President Kennedy in which they indicate that "although the present civil defense program, and in particular the construction of fallout shelters might save a small fraction of the population in a nuclear war, this potential gain is more than offset by the fact that such activity prepares the people for the acceptance of thermonuclear war as an instrument of national policy".

Dr. Pauling, well known to Soviet readers, is among those who convincingly show the monstrous character of thermo-nuclear weapons. His article on the genetic effect of radioactive fallout (No. 10) presents fresh data in support of the demand for the unconditional banning of nuclear tests. Up to December 1962, Pauling writes, the power of all bombs tested by the two sides was about 600 megatons (of which 300 applies to last year alone). In his opinion, the genetic consequences of a 10-megaton bomb explosion throughout the world over a number of generations is equivalent to the death of 52,000 children from radioactive fallout (atomic bomb) plus the death of another 430,000 from the effects of radioactive nitrogen-14 (both atomic and hydrogen bombs). The total number of unborn victims as a result of nuclear tests conducted so far can be worked out from Pauling's estimates as, respectively, a mean figure of 1,200,000 (somewhere between 80,000 and 18 million) and 16 million (between 320,000 and 800 million). What damning evidence these figures provide. It is not surprising therefore that the advocates of militarism have launched a persecution campaign of accusations of "incompetency" against this scientist. Pauling comments on these accusations in a letter to the editors of the *Bulletin* (No. 10).

A number of articles put forward various projects for curtailing the arms race and diminishing the war danger. In the June issue Charles E. Osgood proposes moving nuclear weapons to areas far from major inhabited centres; he explains in great detail that such a step would reduce the number of deaths in the event of war (it should be noted that this article which in fact proceeds from the inevitability of a thermo-nuclear conflict runs counter to the journal's general approach to these questions). In the September issue R. Fisher examines the question of sanctions against possible violators of a disarmament agreement. He considers it preferable in such cases to deprive the guilty party of the privileges enjoyed by a party to the international agreement.

The first issue for 1963 contains a series of articles which take theoretical stock of the present state of mankind; they are written by experts in various branches of knowledge. Professor of history T. von Laue writes of the tragic contradictions between the rational world of modern scientific knowledge and mankind which organises its life along far from rational lines. He ends his article with an appeal for a return to the science of man and better organisation of human relations. Law professor H. Jones expounds his plan for establishing an unbiased supranational "Court of Justice" which could make an objective settlement of international disputes. Economist R. Levine believes that an important contribution towards achieving a gradual rapprochement with the Socialist world could be made by a unilateral U.S. initiative.

A leading American psycho-analyst M. Ostow adduces from his views on consciousness that the "salvation" of mankind depends on greater contacts, reciprocal visits by statesmen, and the fostering of mutual respect between the two camps. It should be noted that all the contributors to this discussion favour a policy of peace, although, like many other writers for the *Bulletin,* they have a rather vague idea of the concrete paths leading to it.

Professor F. Schick's article "International Law in Extraterrestrial Space", published in the November issue, is a reply to the comments made by Y. A. Korovin, Corresponding Member of the Soviet Academy of Sciences,

on Schick's earlier article on the same subject (see *International Affairs*, No. 3, 1962). Our readers will recall that, while Korovin thought many of Schick's ideas about the need for the peaceful use of space were interesting, he also drew attention to some substantial shortcomings. In his reply Professor Schick agrees with Korovin's idea that a peaceful demilitarised cosmos is a natural complement to a pacific Earth.

Schick concentrates on examining those legal rules, which he admits are "partial", by means of which it is already possible to regulate things in paraterrestrial space. It is entirely permissible to concentrate on these aspects of the problem, especially now that the implementation of practical measures of Soviet-American co-operation in space is on the agenda. Without going into a detailed examination of Schick's article, it must nonetheless be remarked that it does not contain an exact definition of peaceful aims in space. The author's passing reference to the need to repudiate "territorial" rights on Earth as well is open to objection.

The plans for averting war put forward by the major nuclear scientist Leo Szilard in his literary and publicist writings have received considerable publicity recently. Following on his fantastic idea of the reciprocal mining of major American and Soviet cities, which created such a sensation about two years ago, Szilard has proposed the organisation of a scientists' anti-war movement. (The Soviet public has already had a chance to read Szilard's lecture on this subject, which was reprinted in abridged form, from the *Bulletin of Atomic Scientists* [No. 4] in the first issue of *International Affairs* for this year.) Szilard reports in the December issue of the *Bulletin* that his Council for Abolishing War has not assumed popular proportions: 2,500 people have joined the movement while Szilard believes that for it to be effective a minimum of 20,000 are required.

Whatever the questions raised by various articles published in the *Bulletin,* the main one is a theme arising from the very nature of the publication—the responsibility for peace borne by those who by their own hands have been creating the weapon with which to destroy it. Just about everyone who is concerned with the question of war and the militarisation of science talks and writes on this subject. Because of this it is sometimes very difficult to draw the line between what is said because it is now customary to say it and what is really an expression of deep concern. It is still more important, however, to perceive the advance from alarm and despondency to an understanding of the need and possibility of working for the good of mankind. The whole range of shades of opinion may be found in the numerous articles, letters and statements on the scientist's role in society which are constantly appearing in the *Bulletin.*

In December 1962, a whole series of articles was published in the journal to mark the 20th anniversary of the day when the first chain reaction was set off in a nuclear reactor (Chicago, December 2, 1942). Almost all the articles express unconcealed alarm that the atomic genie, having been released from its prison, has escaped from the control of those who dreamed of becoming its rational masters: even worse, it has begun to order them about. "We have permitted ourselves to become locked in a vicious circle from which there will be no automatic release," writes Professor H. Brown, of California University and Foreign Secretary of the National Academy of Sciences (No. 10).

Reality has proved to be much more dangerous than cybernetic fantasies about rebellious robots. The picture painted by many Western scientists contains, however, one very serious defect: no account is taken of those social processes and laws, which threaten to make the greatest achievement of human intellect the curse of mankind. This oversimplification is also noticeable in a number of *Bulletin* articles and inexorably takes its revenge: the analysis is incomplete and one-sided.

The idea that the prime duty of scientists today is to tell the people the truth about the threat of a thermonuclear war and to raise a public protest against the adventurist policy of the "wild men" is repeated again and again in the *Bulletin.* This is a correct, humanist idea, and it requires courage to defend it against a background of war hysteria. There are, however, frequent admissions that the small group of anti-militarist-minded scientists are incapable of arousing the mass of the people. The most powerful force in the United States, writes Robert Gomer (No. 6 of the *Bulletin*), is public opinion; but it is startlingly inert and sated with false information, and it is difficult to find the means to wake it up. He doubts whether Szilard will be able to do it with his movement....

The sociologist Hans J. Morgenthau writes (No. 10) that "the atrophy both of democratic control over the government and of responsible government itself" is one consequence of the application of atomic energy and the spreading of secrecy connected with it, etc. His prescription against growing "totalitarianism", incidentally, is very primitive: the revelation of atomic and other secrets to the whole of society. Morgenthau is undoubtedly right when he says that democratic institutions in modern bourgeois society are losing their value. But is this solely the effect of modern technology? Would it not be truer to say that it strengthens and brings to the surface a tendency which existed long before the nuclear reactor was put into action in Chicago? Did not Lenin point out nearly half a century ago the deep internal connection between contemporary capitalism (imperialism) and the decay of parliamentary democracy, and the growing influence of the banks, monopolies, and military staffs.

Underestimation of the impact of social conditions on both military strategy and science is at times evident in unsubstantiated attempts to oversimplify the link-up between the scientific and technical revolution and its creators on the one hand and international relations on the other. This tendency may also be found in some of the

articles published in the *Bulletin*, including those by its editor.

In a number of issues Rabinowitch repeats the thesis that modern weapons have made an anachronism not only of national sovereignty but even of national frontiers. This is what he writes in No. 7 of the *Bulletin:* "Nations must reevaluate the ideals to which their national life ... has been dedicated in the past—the concepts of sovereign nations, national power and grandeur, national security and economic interest"—all in the name of saving mankind. This alone, the author believes, can remove the threat of mankind's destruction. It is quite impossible to regard such a standpoint as realistic. There can be no doubt that modern means of production—and especially atomic energy—have long outgrown national confines and in the long-term view are laying the technical foundations for a world-wide community of nations, but a long and complex path of economic and political development still separates us from this time: today we live in a world consisting of two opposed social systems.

Only in tales of fantasy is it possible to conceive that one fine day countries and peoples will re-evaluate their ideals. There are, in fact, some very just remarks apropos of this in the *Bulletin* itself. "Asking people to renounce national interests, in favor of the interests of mankind, only makes it harder to accept the facts of the world today and suggests a conflict which is in fact non-existent," writes John T. Edsall in a letter to the editors (No. 9). He believes it would be more correct and useful to emphasise that the preservation of peace corresponds to the national interests of all people.

Some elements of a not entirely realistic approach may be noted in statements in a number of articles about the special position of scientists in the modern world.

It is the duty of scientists, the duty of science to help discover realistic ways to peaceful co-existence. In order to fulfil this duty, it is essential to consider both the significance of modern science in the transformation of the character of war, and the laws of development governing society. That is why it is so heartening to read in this journal published by American nuclear scientists appeals for peace and reason, dictated by serious concern for the fate of mankind and based on the real conditions obtaining in the modern world.

6—749 (Англ.)

The New World
(Title + Index page sent to W.)

Bohr's letter contained reports of corroborating experiments at the University of California, Johns Hopkins, and the Carnegie Institution of Washington. The next issue related experiments undertaken at Columbia just after Bohr's arrival in which Fermi and John R. Dunning, joined by a number of younger collaborators, further demonstrated the validity of the results obtained abroad.[4]

This was only the beginning. Scientists throughout the world launched a comprehensive effort to throw light on the phenomena of fission. They published nearly one hundred articles on the subject before the end of 1939. All the great centers of American physical research took up the challenge. In the realm of theory, the prime achievement was a study carried out at Princeton by Bohr and John A. Wheeler. Their work, published in September as "The Mechanism of Nuclear Fission," was rich in insights destined to aid many another scientist in the years ahead.[5] In the experimental field, nothing was more immediately significant than the work being done at Columbia on the possibility of a chain reaction. It was an investigation for which Morningside Heights was well fitted. Here at the Michael Pupin Laboratory was Dunning with the cyclotron and other equipment he had acquired for neutron-reaction studies. Here were Herbert L. Anderson, a gifted graduate student, and Walter H. Zinn, a physicist at City College who did his research in the Columbia laboratories. Here were Fermi, who had no intention of returning to his native land, and Leo Szilard, a Hungarian scientist who had come without benefit of a faculty appointment to work with Fermi. Fortunately, this team was under a sympathetic if somewhat conservative administrator, George B. Pegram. A physicist himself, Pegram was now dean of the graduate faculties.

The men at Columbia had seen from the first that the key to the self-sustaining reaction was the release of neutrons on fission of the uranium atom. Like physicists generally, they had guessed that neutrons were emitted. Their experiments, along with others conducted both in the United States and abroad, soon indicated that this indeed was true. Once the neutron question was settled, another rose to demand attention. Was a chain reaction possible in natural uranium? At Columbia and elsewhere physicists disagreed over which isotope fissioned with slow neutrons, neutrons which traveled at the energies known most likely to produce fission. Was it the rare 235, considerably less than 1 per cent of the natural element, or the abundant 238? Dunning thought 235 was responsible, while Fermi inclined toward 238. Dunning was impressed by the small fission cross section—the physicists' term for probability—of natural uranium. He thought it indicated only a small chance for a chain reaction. But if uranium 235 was the isotope subject to slow-neutron fission, and if it could be concentrated, he considered the chain reaction a certainty. Fermi accepted his colleague's reasoning, but even if U-235 should prove the key, he was content to try for a chain reaction in natural, unconcentrated uranium because of the extreme difficulty and

expense of separating the isotopes. To settle this debate, Fermi and Dunning agreed on a co-ordinated investigation. The Italian would try for a chain reaction in natural uranium, while the American would acquire small samples of concentrated U-235 and see if his views on its susceptibility to fission were correct.[6]

Fermi's first effort to ascertain whether the conditions of a chain reaction existed in normal uranium was to measure the number of neutrons produced per fission. By the middle of March, preliminary experiments indicated that the average was two.[7] The next objective was to discover how extensive was nonfission absorption. Fermi, Szilard, and Anderson knew that neutrons might be captured without fission and produce a radioactive isotope of uranium, U-239. If this happened on an excessive scale, too few neutrons would live to propagate a chain reaction. The experimenters placed a neutron source in the center of a large water tank and made comparisons, with and without uranium in the water, of the number of slow neutrons present. These measurements led them to conclude that a chain reaction could be maintained in a system in which two requisites were met. First, neutrons had to be slowed to low, or thermal, energies without much absorption. Second, they had to be absorbed mostly by uranium rather than by another element. Fermi and Szilard had doubts, however, about the proper agent for slowing down, or moderating, the neutrons. It would have to be some material of low atomic weight. Neutrons, common sense indicated, would lose speed more quickly by collision with light rather than with heavy atoms. Water, which Fermi had used because it was two-thirds hydrogen, had exhibited a tendency to absorb neutrons. On July 3, 1939, the same day the editor of the *Physical Review* received the Columbia results, Szilard wrote Fermi to suggest that carbon might be a good substitute. Szilard saw heavy hydrogen in the form of heavy water as another possibility, for it had less tendency to absorb neutrons than ordinary hydrogen, but he did not know if it could be obtained in sufficient quantity. A few days later, he was so convinced of the advantageous physical properties of carbon that he thought the Columbia group should proceed at once with a large-scale trial employing a graphite moderator without even awaiting the outcome of experiments to determine its neutron-absorption characteristics.[8]

FIRST APPEALS FOR FEDERAL SUPPORT

Publication of the results of the absorption experiments in the summer of 1939 marked a temporary halt to intensive work on the chain reaction at Pupin Laboratory. Fermi departed for the University of Michigan to study cosmic rays. Anderson, his assistant, devoted his time to finishing his Ph.D. investigations, while Szilard, though full of suggestions for accelerating the

experimental work, concentrated on finding a way to alert the federal government to the significance of fission.

Actually, a branch of the government had already been approached. On March 16, Dean Pegram wrote Admiral Stanford C. Hooper, technical assistant to the Chief of Naval Operations, to say that Fermi, who was traveling to Washington on another matter, would be glad to tell Hooper of the experiments at Columbia. It was possible, Pegram wrote, that uranium might be used as an explosive that would "liberate a million times as much energy per pound as any known explosive." Pegram thought the probabilities were against this but that even the barest possibility should not be ignored. At the Navy Department the next day, Fermi talked for an hour to a group that included a number of naval officers, two civilian scientists from the Naval Research Laboratory, and several officers from the Army's Bureau of Ordnance. Fermi explained the Columbia efforts to discover whether or not a chain reaction could take place. He was not sure that the experiments would yield an affirmative answer, but if they did, it might be possible to employ uranium as an explosive. After some questioning, a Navy spokesman told Fermi that the Department was anxious to maintain contact with the Columbia experiments and undoubtedly would have representatives call in person.[9]

The most responsive of the listeners that afternoon were the scientists of the Naval Research Laboratory. They had a long-standing interest in a source of power that would permit protracted undersea operations by freeing submarines from dependence on tremendous supplies of oxygen. As soon as the news of fission broke in January, they had contacted the men at the Carnegie Institution who were checking the work of Meitner and Frisch. Just three days after the conference with Fermi, Admiral Harold G. Bowen, director of the NRL, recommended that the Bureau of Engineering help finance investigation of the power potential of uranium. The Bureau allotted $1,500 to the Carnegie Institution, which agreed to co-operate but for reasons of internal policy did not accept the grant. The NRL also approached Jesse W. Beams, a centrifuge expert at the University of Virginia, on isotope separation.[10]

The initiative for a new overture to the federal government in the summer of 1939 came in large part from Szilard, an impetuous, imaginative physicist who was at his best in goading others to action. The news of fission alarmed him, for he feared that it might lead to powerful explosives which would be dangerous in general and particularly so in the hands of Nazi Germany. Like many others, he hoped a bomb would prove impossible. But until this could be established, there seemed only one safe course: to pursue the work vigorously.[11] Szilard had been zealous on behalf of the Columbia experiments and had even borrowed money to rent radium for use in a neutron source.

Szilard was eager for some sort of federal action. At a June meeting of the American Physical Society in Princeton, he had consulted Ross Gunn,

who, as the technical adviser of the Naval Research Laboratory, was at the center of the Navy's interest in the potential of uranium. On July 10, Gunn informed him that though the NRL was anxious to co-operate, restrictions on government contracts for services made it impossible to carry through any agreement that would be helpful.[12]

Frustrated, Szilard talked over the situation with physicist Eugene P. Wigner, also a native of Hungary. Szilard by now was convinced that the uranium-graphite experiment might quickly prove successful if only it could be carried out. More than ever, he thought it imperative to get on with the work. Besides, it was high time to take steps to keep the uranium ore of the Belgian Congo out of German hands. It occurred to the two physicists that Albert Einstein was the logical person to alert the Belgians, for he knew the royal family. They saw Einstein, who agreed to dictate a letter of warning, though to someone below that rank. Since this maneuver raised the propriety of communicating with a foreign government, Wigner suggested that they send the Department of State a copy with a note that Einstein would dispatch the letter in two weeks unless he received advice to the contrary. This, however, would do nothing to expedite research in the United States. Szilard believed that they should make some direct advance to the government in Washington. At the suggestion of Gustav Stolper, a Viennese economist and a friend of long standing, he went to see Alexander Sachs, a Lehman Corporation economist reputed to have ready access to the White House.

Quiet and unpretentious in appearance but curiously florid and involute in speech, Sachs prided himself on his skill in analyzing current developments and predicting the course of events. He specialized in "prehistory," he liked to say. Since 1936, when he had heard Lord Rutherford lecture, the work of the atomic physicists had intrigued him. Then early in February, 1939, while Sachs was visiting in Princeton, Frank Aydelotte, director of the Institute for Advanced Study, showed him a copy of a letter that Bohr had addressed to the editor of *Nature*. Sachs's excitement increased as the months went by and further experiments were reported. By the time Szilard called on him in July, he remembered some years later, he had already pointed out to the President the crucial character of the new developments. From Roosevelt, Sachs understood that the Navy had decided not to push uranium research, largely because of the negative attitude of Fermi and Pegram.

To approach the President successfully, Sachs believed it was necessary to counter the impression created by the Columbia physicists. This would require the testimony of a scientist more eminent than Szilard. The obvious solution was to enlist the name of Einstein. A letter should be prepared for his signature. Sachs could insure that such a communication, along with supporting scientific papers, received Roosevelt's attention.

The letter that emerged from conferences between Sachs and Szilard reported that recent work by Fermi and Szilard in America and by Joliot-Curie in France made a uranium chain reaction almost a certainty in the immediate

future. This would mean the generation of vast amounts of power and the creation of new radium-like elements. It was conceivable, though still not definite, that extremely powerful bombs could be constructed. These might prove too heavy to be dropped from an airplane, but they could be carried by boat and exploded in a port. The supplies of uranium ore in the United States were not extensive. Although there was some good ore in Canada and in Czechoslovakia, the Belgian Congo was the most important source. Something ought to be done to maintain contact between the Administration and the physicists working on the atom. Perhaps the President could assign someone, possibly in an unofficial capacity, to keep the appropriate government departments informed and make recommendations for action, particularly on raw materials. This agent might also seek to speed research by soliciting contributions from private individuals and by obtaining the co-operation of industrial laboratories. Closing the letter was a warning of German interest. The Reich had stopped the sale of uranium from Czechoslovakian mines.

At Sachs's request, Szilard drafted an accompanying memorandum. Seeking to explain more clearly the underlying science, the physicist stressed that a chain reaction based on fission by slow neutrons seemed almost certain even though it had not yet been proved in a large-scale experiment. Whether a chain reaction could be maintained with fast neutrons was not so certain. If it could be, it might be possible to contrive extremely dangerous bombs.

It was not hard to persuade Einstein to sign the letter, but before Sachs could take the completed dossier to Roosevelt, war broke out in Europe. Sachs delayed, for he wanted to present the case to the President in person, so that the information "would come in by way of the ear and not as a sort of mascara on the eye." He knew that Roosevelt, preoccupied with the international crisis and his fight to win repeal of the arms-embargo from a reluctant Congress, was unlikely to give the uranium recommendations adequate attention. But early in October, 1939, the time seemed more propitious, and Sachs arranged an appointment for the eleventh. At the White House, the President's secretary, General Edwin M. Watson, had called in two ordnance specialists from the Army and Navy, Colonel Keith F. Adamson and Commander Gilbert C. Hoover. After Sachs had explained his mission to them, he was taken in to see the Chief Executive. Sachs read aloud his covering letter, which emphasized the same ideas as the Einstein communication but was more pointed on the need for funds. As the interview drew to a close, Roosevelt remarked, "Alex, what you are after is to see that the Nazis don't blow us up." Then he called in "Pa" Watson and announced, "This requires action." [13]

This appeal for federal encouragement, if not support, of research touched a theme that went back to the Constitutional Convention of 1787. The powers expressly granted the general government seemed to imply a place for science, but just what this might mean awaited the resolution of

constitutional issues that involved science only tangentially. As it worked out, Americans were slow to accept the idea that the federal government should have a permanent scientific establishment. Not until after the Civil War did a well-diversified corps of scientific bureaus evolve. By 1916, the process was largely complete. Since the several units had appeared at different times under widely varying auspices in response to the demands of society, there was no central organization. The emphasis was on applied rather than basic research.

This setup seemed reasonably well adapted to the day-to-day requirements of the government. All efforts had failed, however, to work out a satisfactory arrangement by which American science as a whole could serve in an advisory capacity in times of national emergency. The first attempt to achieve such an arrangement was the creation of the National Academy of Sciences. A group of scientists led by Alexander Dallas Bache made the Civil War the occasion for promoting their long-cherished plan to establish a self-perpetuating national academy which should serve the dual purpose of honoring scholarly attainment and of advising the government. Taking advantage of the end-of-session rush in March, 1863, they spirited the necessary legislation through Congress. Unfortunately, the wartime accomplishments of the National Academy were slight. Only through the efforts of Joseph Henry, the secretary of the Smithsonian, did the National Academy survive the crisis which saw its birth.

The first World War brought forth another effort to forge a working relationship between government and science. The National Research Council was organized in 1916 under the auspices of the National Academy to broaden the base of scientific and technical counsel. Not limited to members of the National Academy, the NRC sought the help of scientists generally, whether they were at work in government, the universities, private foundations, or in industry. Though it met the test of war by establishing co-operative research on a large scale and by serving as a scientific clearing-house, it left much to be desired. Never financed independently, the only effective way it could obtain funds from the military was to have its scientists commissioned. It was further handicapped by losing to the services the initiative of suggesting projects. After the Armistice, the NRC evolved into an agency for stimulating research by dispensing Rockefeller and Carnegie money. Though this was useful enough, the council lost the capacity to serve as an active scientific adviser. In many ways, a more significant development of the war years was the establishment of the National Advisory Committee for Aeronautics, an independent board of both government and private members with functions less advisory than executive.

It was not surprising that a new effort at establishing efficient liaison between government and science emerged in the summer of 1933. Isaiah Bowman, chairman of the National Research Council, used Henry Wallace's

request for advice on the reorganization of the Weather Bureau as an opportunity to advocate a general review of government science. The result was a Presidential order creating a Science Advisory Board with authority under the National Academy and the NRC to appoint committees on problems in the various departments. This order named Karl T. Compton chairman. Compton, president of the Massachusetts Institute of Technology, promptly put subcommittees to work studying the government bureaus, but he had larger plans, plans which amounted to a New Deal for science. It was his idea that a large sum—in the final version $75 million in five years—should be spent to support scientific and engineering research. Programs would be formulated by the National Academy, the National Research Council, and a new advisory panel. Compton's dreams failed to win approval, apparently because of their scale and because of a reluctance to adopt a program that would support the natural sciences to the exclusion of other fields of learning. The Science Advisory Board itself did not survive for long. Thus was lost an opportunity not only to support science in the monetary sense but also to establish a rational basis for co-operation between the government and the great centers of investigation. There was still a hope that the National Resources Committee, which had its origin in the faith of social scientists in planning as the basis for sound governmental operation, might accomplish something. But although its science committee made a brilliant study of the federal research agencies and took the broad view that research was a basic national resource, it never gained the administrative position or the support from scientists that were essential for it to become an adequate instrument for mobilizing the nation's scientific strength.[14]

This, then, was the situation when Sachs talked with the President. Roosevelt's thinking must have been conditioned by the rather uneasy relations that had existed between the Administration and the scientific community. There was little basis for sentiments of mutual confidence. No adequate machinery was at hand. One alternative was to refer the matter to the National Academy of Sciences, but this was an unwieldy expedient, and there was little reason to believe it would be fruitful. Besides, every instinct would lead the President to conclude that security as well as policy dictated caution. Why not restrict consideration, for the present at least, to official circles? Whatever the reasoning, action came quickly. Roosevelt appointed an Advisory Committee on Uranium to investigate the problem in co-operation with Sachs. Its chairman was Lyman J. Briggs, a government scientist who had begun his career in 1896 as a soil physicist in the Department of Agriculture and was now director of the National Bureau of Standards. Other members were Commander Hoover and Colonel Adamson. This was a rational solution. Sachs later claimed he had suggested placing the Bureau of Standards in charge as a means of achieving a fresh view, a view uncomplicated by military prejudices. This may have been the case, but there

was a more obvious explanation for appointing Briggs. This, after all, was a problem in physics. Why not have it investigated by the Government's physics laboratory?

Briggs called a meeting at the Bureau of Standards for October 21, 1939. Joining the committee members and Sachs were two Washington physicists—Fred L. Mohler of the Bureau of Standards and Richard B. Roberts of the Carnegie Institution—and three physicists of Hungarian origin—Szilard, Wigner, and Edward Teller. The latter three were invited at Sachs's initiative. Sachs also had arranged for Einstein to be invited but the shy genius did not accept. Szilard focused the discussion by pointing out that it seemed quite possible to attain a chain reaction in a system composed of uranium oxide or metal and carbon in the form of graphite. The principal uncertainty was the lack of information on the absorption of slow neutrons by the graphite moderator. Szilard and Fermi had devised experiments for measuring this. If the absorption cross section should be either small or large, they would know at once whether the chain reaction would or would not work. If they obtained an intermediate value, they would have to conduct a large-scale experiment. Some of those present were openly skeptical about the chance for a chain reaction, but the three Hungarians were optimistic. In a sequence that bordered on comedy, the meeting drifted into a discussion of government financing, which was not the immediate objective. As Szilard recalled it, Teller referred quite incidentally to the amount of money that researchers could spend profitably in the months ahead. Colonel Adamson made this the occasion for a discourse on the nature of war. It usually took two wars, he said, to develop a new weapon, and it was morale, not new arms, that brought victory. These sentiments moved Wigner, who had been fidgeting in his chair, to venture the opinion that if armaments were so comparatively unimportant, perhaps the Army's budget ought to be cut by 30 per cent. "All right, you'll get your money," Adamson snapped.[15]

The Advisory Committee on Uranium reported to the President on November 1 that the chain reaction was a possibility, but that it was still unproved. If it could be achieved and controlled, it might supply power for submarines. If the reaction should be explosive, "it would provide a possible source of bombs with a destructiveness vastly greater than anything now known." The committee believed that despite the uncertainties, the Government should support a thorough investigation. It urged the purchase of four tons of pure graphite at once and the acquisition of fifty tons of uranium oxide in the event that the preliminary investigations justified continuing the program. To provide for the support and co-ordination of these investigations in different universities, Briggs and his colleagues advocated enlarging their committee to include Karl Compton, Einstein, Pegram, and Sachs.

On November 17, Watson wrote Briggs that the President had noted the report with deepest interest and wished to keep it on file for reference.

The President also wanted to be sure that the Army and Navy had copies. There was no further word from the White House until February 8, 1940, when Watson told Briggs he intended to bring the report to the President's attention again. Was there anything Briggs could add as a personal recommendation? Briggs replied on February 20 that the Army and Navy had transferred funds "to purchase materials for carrying out a crucial experiment on a satisfactory scale." He hoped for a report in a few weeks. It would show "whether or not the undertaking has a practical application." These brief sentences referred to $6,000 that the military services had granted for the purchase of supplies for experiments with the absorption qualities of graphite. By the time Briggs answered Watson, both the President and his aide had departed on a trip that would keep them away from Washington until about the first of March.[16]

The little group that had sought to interest the President the preceding autumn was dissatisfied. Early in February, Sachs obtained a copy of the November 1 report from General Watson. Now he could see what was wrong, he wrote Watson: the paper had been too academic in tone to make its practical point. Sachs asserted that Einstein thought the situation looked even better than earlier. Sometime during the coming month, the economist announced, he would submit a new appraisal.[17]

Meanwhile, Joliot-Curie reported his measurements of a uranium-and-water system. The Frenchman's encouraging results stimulated Szilard to greater confidence in his own uranium-graphite approach. Rumors that the Nazis had secretly intensified their uranium research made action seem especially urgent. Again Szilard saw Einstein. Resorting to pressure tactics in the hope of forcing Government action, he showed Einstein a manuscript on a graphite system that he was sending to the *Physical Review* for publication. Einstein reported the new developments to Sachs. On March 15, Sachs relayed the communication to the White House. In view of the brighter experimental outlook, he asked, would the President be able to confer on the practical issues it raised? [18]

The first response was disappointing. Watson replied on March 27 that he had delayed until he could speak with Colonel Adamson and Commander Hoover. They had come in that afternoon, and Adamson had said that everything depended on the Columbia graphite experiments. Under these circumstances, Watson thought "the matter should rest in abeyance until we get the official report." Within a week, however, there was encouraging news from the White House. On April 5, the President thanked Sachs for forwarding the Einstein letter. He had asked General Watson, he said, to arrange another meeting in Washington at a time convenient for Sachs and Einstein. Roosevelt thought Briggs should attend as well as special representatives from the Army and Navy. This was the most practical method of continuing the research. ". . . I shall always be interested to hear the results," he said.

The same day, Watson sent Briggs a copy of the letter to Sachs and asked for suggestions "so that this investigation shall go on, as is the wish of the President." [19]

March, 1940, had brought a new interest in uranium. The development that touched it off was the conclusive demonstration that uranium 235 was the isotope that fissioned with slow neutrons. While Fermi had been investigating the chain reaction in natural uranium, Dunning had organized his attempt to determine the fissionable isotope. He had persuaded Alfred O. C. Nier of the University of Minnesota, the country's foremost expert on the mass spectrometer, to prepare small samples of partially separated U-235. Dunning and his co-workers at Columbia, Eugene T. Booth and Aristid V. Grosse, made the necessary measurements. In the March 15 and April 15 issues of the *Physical Review*, they presented definite confirmation of what so many had suspected was the role of the lighter isotope.

This was an event of profound significance. If uranium 235 could be concentrated, there seemed no question that a slow-neutron chain reaction was possible. This meant power. A bomb, however, remained highly doubtful. Some physicists already saw that a bomb depended on fission by fast neutrons. If they had to rely on slow neutrons, the metal would tend to blow itself apart before the reaction had gone far enough. It was questionable if the resulting explosion would have sufficient magnitude to justify its cost. The Dunning-Nier experiments indicated that uranium 238 would undergo fission under fast-neutron bombardment, but it did not seem likely that the heavier isotope would sustain a chain reaction. The cross section or probability of fission was too small. What about U-235? Might not it be susceptible to fission by fast as well as slow neutrons? Some physicists thought it was probable. If this were the case, there was a good chance of an explosive reaction in a highly concentrated mass of the lighter isotope. Still, it was only theory. All that was known definitely was that fast neutrons had a lower probability of causing fission in U-235 than slow ones. In the absence of samples substantially enriched in 235, physicists could not determine its fast-fission cross section experimentally.[20]

Whatever might be the possibility of an explosive, the first task was to prove the chain reaction. On March 11, Pegram sent Briggs advance word on the role of U-235. On April 9, Briggs reported to Watson that it was "very doubtful whether a chain reaction can be established without separating 235 from the rest of the uranium." He recommended an intensive study of methods of isotope separation. By this time, interest in uranium 235 had spread widely. It found a focus at the meeting of the American Physical Society in Washington the last week in April. There Gunn, Beams, Nier, Fermi, Harold C. Urey of Columbia, and Merle A. Tuve of the Carnegie Institution discussed its significance for the chain reaction. The next step, they agreed, was to separate U-235 in kilogram quantities. Of the various possible

methods, the centrifuge alone seemed to offer much hope. They decided to try to acquire the funds necessary to determine its potential.[21]

On Saturday afternoon, April 27, the Advisory Committee on Uranium met at the National Bureau of Standards. Joining Briggs, Adamson, and Hoover were Admiral Bowen, Sachs, and four university physicists—Pegram, Fermi, Szilard, and Wigner. Einstein again had declined to attend. Of the scientists, Szilard was the most optimistic concerning the chain reaction, though he could say nothing very explicit about the prospect for an explosive. Sachs urged prosecuting the work more vigorously. If the Government was not disposed to undertake it, he favored trying to finance it from private sources. Sachs was impatient with Fermi's conservative position. If the United States would plunge ahead, he thought, the difficulties experienced in the laboratory would tend to disappear. The Advisory Committee agreed on the need for investigation, but it was ready to proceed on only a small scale and a step or two at a time. As Briggs reported to Watson on May 9, the committee did not care to recommend a large-scale try for a chain reaction until it knew the results of the graphite measurements at Columbia. These were expected in a week or two. If the large-scale experiment was undertaken, the Army and Navy should supervise it at one of the proving grounds. As for methods of separating isotopes, the committee favored supporting the investigations of scientists in various universities but did not favor attempting such studies on a secret basis.[22]

Briggs made some progress in May. He spent the first day of the month at Columbia. On the sixth, Pegram reported the consensus of a conference with his colleagues Fermi, Urey, and Dunning. If support could be obtained from the Navy or elsewhere, they favored tests on a laboratory scale to determine which method appeared best for concentrating substantial amounts of U-235. They proposed to enlist the principal isotope-separation specialists and launch the work in June, when the academicians among them could escape their teaching duties. On May 8, Pegram explained to Briggs what was involved in proving the chain reaction in a uranium-graphite system. On May 14, Pegram announced that Fermi and Szilard had found the absorption cross section of graphite encouragingly small.[23]

As the outlines of a sensible program emerged, pressure for action intensified. Sachs had no intention of leaving everything to Briggs. He argued the cause in May letters to Roosevelt and Watson. Now that Fermi and Szilard had determined the characteristics of graphite, it was time to move. The Nazis were overrunning Belgium; something should be done to safeguard the uranium ore of the Congo. The research program should have larger financial support as well as a better and more flexible organization. Perhaps a nonprofit corporation with official status under the President could make the arrangements necessary to further the work.[24]

More important were the repercussions of the talks at the American

Physical Society meeting. Gunn at once recommended to Admiral Bowen that the Naval Research Laboratory foster a co-operative research effort. Apprised a few days later of the Columbia proposals on isotope separation, Bowen asked Urey to organize an advisory committee of scientific experts to counsel the President's Committee on Uranium. Urey conferred with Briggs and soon had a list of physicists and chemists he thought would be helpful.

The stirrings at the Naval Research Laboratory were echoed a few miles to the north at a private center for scientific research, the Carnegie Institution. Tuve prepared notes for the information of his chief, Vannevar Bush. Though Tuve thought submarine propulsion appeared more practical at the moment than a bomb, he judged that the interests of national defense justified trying to develop the centrifugal system of separation. His recommendations led Bush to call a conference for May 21. The discussion convinced him that the centrifuge deserved support. Bush telephoned Briggs that he would wait to see what funds the Government furnished. If there should be a gap, the Carnegie Institution might step in.[25]

Briggs was pleased at Bush's assurances that his only purpose in calling the conference was to determine how the Carnegie Institution might be helpful. This kept the way clear for the scientific subcommittee. Briggs and Urey soon settled on a membership consisting of Urey himself, Pegram, Tuve, Beams, Gunn, and Gregory Breit, a professor of physics at the University of Wisconsin. This group reviewed the whole subject at the Bureau of Standards on June 13 and advocated support for investigations of both isotope separation and the chain reaction.[26]

ENTER THE NDRC

A new force now appeared on the scene—the National Defense Research Committee. An effort to organize American science for war, it owed its existence to Vannevar Bush. A shrewd, spry Yankee of fifty—plainspoken, but with a disarming twinkle in his eye and a boyish grin—Bush was well known for his original work in applied mathematics and electrical engineering. During the first World War he had worked for the Navy on submarine-detection devices. Though he then turned to teaching, his talent for invention did not atrophy. From his fertile brain came many ingenious innovations, including an essential circuit for the automatic dial telephone. In 1939, he resigned the vice-presidency of the Massachusetts Institute of Technology to become president of the Carnegie Institution, a post that put him close to the nerve center of the embryonic defense effort. Soon he moved up from member to chairman of the National Advisory Committee for Aeronautics, and when war broke out in Europe, he cast about for some way of organizing American science for the test that lay ahead. After discussions with Karl Compton, with President James B. Conant of Harvard, with President

Frank B. Jewett of the National Academy of Sciences, and with his colleagues at the NACA, he evolved a plan for a committee that would have the same relation to the development of the devices of warfare that the NACA had to the problems of flight.

Early in June, 1940, when Nazi Panzer divisions were thrusting deep into France, Bush persuaded President Roosevelt to place him at the head of a National Defense Research Committee. Under the authority of the old World War I Council of National Defense, from which it was to draw its funds, the NDRC was to supplement the work of the service laboratories by extending the research base and enlisting the aid of scientists. Even more important, it was to search for new opportunities to apply science to the needs of war. It could call on the National Academy and the National Research Council for advice and on the National Bureau of Standards and other government laboratories for more tangible assistance. The NACA, already functioning well under Bush's leadership, lay outside the jurisdiction of the new agency. Not so the Committee on Uranium. It was to report directly to Bush, and the NDRC was free to support its work.[27] The NDRC did not owe its birth to uranium, but the pressure applied by those who had caught the vision of a chain reaction made Bush's organizational plan seem all the more attractive.

The new committee was an important factor in mobilizing the scientific resources of the nation. The NDRC did not have to wait for a request from the Army or Navy but could judge what was needed for itself. It was not limited to advising the services but could undertake research on its own. For the uranium program, its creation was an event of great significance. It freed uranium from exclusive dependence on the military for funds. More important, it rescued this novel field of research from the jurisdiction of an informal, *ad hoc* committee. By providing a place within the organizational framework of the defense effort of American science, the NDRC made it easier for nuclear scientists to advance their claims.

By the early autumn of 1940, Bush had reorganized the Committee on Uranium and adjusted it to its new place in the scheme of things. Guided by instructions from the President, he retained Briggs as chairman but dropped Commander Hoover and Colonel Adamson because the NDRC was now the proper channel for liaison with the military. To strengthen the scientific resources of the group, he added Tuve, Pegram, Beams, Gunn, and Urey. The new regime stressed security. One manifestation was the exclusion of any foreign-born scientists from committee membership, a policy adopted in deference to Army and Navy views and with at least one eye on future encounters with Congress. The other manifestation—arrangements for blocking the publication of reports on uranium research—originated with the scientists themselves. Szilard had sought in vain to accomplish this on an international scale back in February, 1939. In the spring of 1940, Breit sparked the establishment within the framework of the National Research Council of

a reference committee to control publication of any research that had military significance. Uranium fell within its scope; indeed, the desire to control publication on fission phenomena prompted the ban.[28]

FORMULATING A PROGRAM

Though the NDRC would control the funds, it remained the duty of the Briggs committee to formulate a program. One of its concerns was uranium ore. There were no significant stockpiles in the United States, for the only commercial use of uranium was as a coloring agent in the ceramic industry. Of the 168 tons of oxides and salts American users consumed in 1938, only 26 came from domestic carnotite ores mined in the Colorado Plateau. The remainder was imported: 106 tons from the Belgian Congo and 36 from Canada. Early in June, 1940, Sachs urged Briggs to have someone make an overture to the Union Minière du Haut Katanga, the company that owned the Congo mines. He thought Union Minière might be persuaded to ship ore to the United States and, while retaining title, commit itself not to re-export without special permission. Briggs promptly authorized Sachs to make the necessary inquiries. The company showed no immediate interest in such a scheme, though later in 1940 its affiliate, African Metals Corporation, imported 1,200 tons of 65-per-cent ore and stored it in a Staten Island warehouse.[29]

Research, not raw materials, seemed the proper emphasis in June, 1940. Ore would become important when and if production was warranted, but with funds limited and with so little known about the defense potential of uranium, the Briggs committee did not deem it prudent to acquire large stocks of raw materials. There would be time enough when research had indicated the extent of the requirements.

The Committee on Uranium addressed itself to research on June 28. It accepted the findings of its scientific counselors that ample justification existed for supporting work on isotope-separation methods and for further efforts to determine the feasibility of a chain reaction in normal uranium. On July 1, Briggs gave Bush a report on his stewardship. He announced with gratification that the War and Navy Departments had approved a thorough study of separation. An allotment of $100,000 had already been made, which the Naval Research Laboratory would administer with the advice and assistance of the Committee on Uranium. That still left the chain reaction to be provided for. Briggs urged that the NDRC set aside $140,000 for two types of investigation: first, studies to determine more accurately the fundamental physical constants and, second, an intermediate experiment involving about one-fifth the amount of material judged necessary to establish the chain reaction.[30]

The NDRC approved the uranium recommendations in principle on

July 2 and asked Briggs to place them in definite form for consideration when funds became available. Briggs arranged for full presentations by Pegram and Fermi, and on September 6, Bush told him that the NDRC had agreed to assign $40,000. This was enough to finance the work on physical constants but not enough to undertake the intermediate experiment.[31]

RESEARCH: THE CHAIN REACTION

The chain reaction in natural uranium still had high priority despite the demonstration that it was only the lighter isotope 235 that contributed to slow-neutron fission. Many still thought that the expense made the isotope-separation approach impractical. To them it seemed essential to strive for a definite answer on unseparated uranium. If such a chain reaction did prove possible, to what use should it be put? In the summer of 1940, American scientists saw it first as a source of power. All of them, certainly, had thought of the possibility of a bomb. Some believed that in achieving a chain reaction they might gain understanding of what it took to make a bomb. But scientists in America did not direct their thinking primarily toward a weapon. When Pegram and Fermi outlined the research plans for the Columbia team in August, they listed their objectives only as power and large amounts of neutrons for making artificial radioactive substances and for biological and therapeutic applications.

More than a year of research had left the prospects for a chain reaction uncertain. The problem remained the same: to discover if enough of the neutrons produced by fission survived to keep the reaction going indefinitely. When one neutron produced fission, at least one of the neutrons emitted had to live to repeat the process. If this reproduction factor, which physicists were beginning to express by the symbol k, was one or better, the chain reaction was a fact. If it was even slightly less than one, the reaction could not maintain itself. In a uranium-graphite system there were three obstacles to a satisfactory reproduction factor. One was nonfission capture of neutrons by uranium. Another was their absorption by impurities such as might exist in the moderator. A third was escape from the surface. The larger the system, the less serious was the danger that the vital particles would be lost. This was so because the volume of the mass, where neutrons produced fission, increased more rapidly than its surface, where they escaped.

Fermi and his group at Columbia did not wait until the NDRC contract came through on November 1, 1940. First, they checked their work of the preceding spring on the neutron-absorbing characteristics of graphite. Their technique was to introduce a few grams of radon mixed with beryllium as a neutron source into a square column, or pile, of graphite a few feet thick. As the neutrons diffused through the column, they induced radioactivity in sensitive strips of rhodium foil that had been inserted as detectors.

This was work that Fermi especially enjoyed. Since the radioactivity in the rhodium was short-lived, the foil had to be placed under a Geiger counter within twenty seconds. Fermi would race down the hall to his office, where the counter had been placed to keep it from being disturbed by the neutron source in the laboratory, put the foil in place, and then delightedly tap his fingers in time with the clicking of the register. The measurements confirmed not only the suitability of graphite as a moderator but also led to a mathematical method for developing the life history of a neutron.

The second step for the Fermi team was to determine the average number of neutrons emitted by natural uranium when it absorbed a slow neutron. This was a value bound to be smaller than the number of neutrons emitted per fission, since not every absorption by a uranium atom produced fission. The experimenters rebuilt the graphite column to permit the insertion of a layer of uranium in a region where practically all of the neutrons had been slowed. Now it was easy to distinguish neutrons emitted by the uranium from those originated by the source. The value Fermi derived, 1.73, was so low that, although it did not rule out a chain reaction, it emphasized the necessity of keeping parasitic losses to a minimum. During the course of these experiments, Szilard brought forward the idea that if the uranium were arranged in lumps instead of being spread uniformly throughout the graphite, a neutron was less likely to encounter a uranium atom during the process of deceleration, when it was particularly susceptible to nonfission absorption. With heavy reinforcement from a new research group at Princeton, the investigators turned to explore the possibilities of Szilard's suggestion. By the spring of 1941, they had accomplished enough to gain a good understanding of the processes involved and of the arrangements most likely to minimize the unfavorable factors.[32]

While the basic work of measurement was proceeding, the physicists made plans to find out how large a pile with a given arrangement, or lattice, of uranium lumps should be in order to maintain a chain reaction. One way would have been to begin building a full-scale pile. When it started to react, they would know the necessary dimensions. If it should become impractically large without going critical, they could conclude that something was fundamentally wrong. But they had already rejected this crude and expensive technique, for it would delay reliable judgments until large quantities of materials had been amassed. A better method was to construct an intermediate-sized, or exponential, pile. This would make possible an informed, though not conclusive, opinion much earlier and at much less cost.[33]

It proved difficult to acquire suitable materials even in small quantities. Despite the co-operation of the Bureau of Standards, of Metal Hydrides, a producer of powdered metal alloys, and of the research laboratories of the Westinghouse and General Electric companies, the Briggs committee could find no dependable method of manufacturing either nonpyrophoric uranium powder or pure ingots. This disappointment forced the Co-

lumbia experimenters to turn to uranium oxide, even though the chances of success with this were less. Nor did it prove easy to acquire graphite low in boron, an absolute essential because of the strong neutron-absorbing characteristics of boron. By May, 1941, Briggs had placed orders for forty tons of graphite with the United States Graphite Company and for eight tons of uranium oxide with Eldorado Gold Mines, Ltd., of Canada. Not until these orders had been filled would it be possible to proceed with the intermediate experiment.[34]

The Fermi work at Columbia aimed at a uranium and graphite pile, but the Briggs committee considered other moderators as well. In November, 1940, Nobel Prize winner Arthur H. Compton, brother of Karl and chairman of the Department of Physics at the University of Chicago, suggested a beryllium moderator. Beryllium had not only the essential low atomic weight, he argued, but also the advantage that it would add rather than remove neutrons and thus contribute to a successful chain reaction. Two months later the NDRC let a contract for Samuel K. Allison to make the necessary measurements at Chicago. Meanwhile, it had not been forgotten that heavy water might be useful, both as a moderator and as an agent for removing the heat generated in a uranium-graphite pile. Early in 1941, Urey, the discoverer of heavy hydrogen, began to press for action. Urey, also the winner of a Nobel Prize, was interested in the experiments of Hans von Halban and Lew Kowarski. These co-workers of Joliot-Curie had fled to England at the fall of France with a few bottles of heavy water which constituted practically the world supply. Their studies now seemed to indicate a good chance of obtaining a chain reaction in a heavy-water and uranium-oxide system. Perhaps, Urey worried, the Germans were already ahead in this approach. Americans should study methods for producing large quantities of heavy water. By June, he had won Briggs's support and had done enough work himself to be able to submit a comprehensive report on the subject.[35]

RESEARCH: ISOTOPE SEPARATION

The big change in the uranium program after June, 1940, was the emphasis on isotope separation. The proof of U-235 fission by slow neutrons had dictated this second approach to the chain reaction. The scientists interested in isotope separation recognized the possibility of a bomb, but most of them, like the men working on normal uranium, were thinking mainly of a source of power.

Isotope separation appeared incredibly difficult. An isotope differed from its sister substances in mass—that is, in the number of neutrons in its nucleus—but not in atomic number. For most practical purposes, therefore, separation depended not on chemical methods but on some process involving

co-ordinate the dispersed activities of the laboratory, Compton designated Doan as director with Fermi, Allison, and Wigner as co-ordinators of the research, experimental, and theoretical aspects of the chain reaction. Breit would continue to co-ordinate fast-neutron research at a half-dozen universities, while Szilard would be in charge of the supply of materials. For the time being, Seaborg would keep his research on plutonium chemistry at Berkeley. With this organization and the small supply of uranium oxide and graphite Compton hoped to show by April 15 whether a chain reaction would in fact be possible.

Initially, Compton was relying on the exponential pile which Allison was constructing in the racquets court under the West Stands. The stacking of high-purity graphite and uranium-oxide units continued during February until Allison had a block ninety inches on a side resting on a twelve-inch wooden base. Two horizontal channels at right angles in the bottom four inches of the pile permitted the insertion of radium-beryllium neutron sources. By the first of March, Allison was ready to begin the complicated measurements which might indicate the possibilities of a chain reaction.[7]

What the results would be, no one knew. But even Compton did not let his enthusiasm hide the realities. On February 10, he urged Conant to order one or two tons of heavy water and a kilogram of uranium 235 in case the experiment with natural uranium and graphite failed.

HOPES FOR A SHORT CUT

Even more spectacular than the pile project was Lawrence's electromagnetic method of separating the 235 isotope. Late in November, 1941, Lawrence had assembled a special task force of his best scientists and technicians to convert the 37-inch cyclotron. The flat cylindrical vacuum tank was rolled out of the eight-inch gap between the magnet poles, and the cyclotron equipment within the tank was replaced by hastily built components of a mass spectrograph. Controls for the ion source, which closely resembled Nier's, pierced one side of the tank. Electrical heaters vaporized solid uranium chloride in the source. The vapor then flowed to a second chamber, where electrons from a heated cathode ionized the gas. A slit two inches long and 0.04 inch wide permitted a ribbon of positively charged ions to escape into the vacuum tank. An electrode with a very large voltage just in front of the chamber accelerated the ion beam. In a plane perpendicular to the magnetic field, the beam would follow a circular path about two feet in diameter to the receiver on the opposite side of the vacuum tank. After traveling through a 180-degree path, the heavier 238 ions could be expected to hit the receiver a small fraction of an inch farther from the center of the tank than would the 235 ions. Between the source and receiver, a movable shield with a narrow defining slit permitted the operator to select the best part of the beam. The re-

various shapes using an argon atmosphere in an electric furnace. The National Carbon Company studied designs of the graphite units and suggested improvements.

Meanwhile, Leverett was exploring the thermodynamics of the cooling system. He had to know the rate of heat transfer from the uranium metal to the helium coolant. Then he had to balance out such factors as the helium pressure drop through the pile, the temperature increase in the helium, the maximum uranium and graphite temperatures, and the rate of helium flow. For this purpose he planned a small helium cooling system consisting of tanks, pumps, heat exchangers, and full-scale models of the uranium-graphite cartridges. By September, 1942, Leverett had obtained the necessary components and had hired a contractor to assemble them in an unheated area under the North Stands of Stagg Field. With autumn coming on, he hoped to complete his experiments before freezing weather set in.

The preliminary design which Moore and Leverett submitted to Compton on September 25 closely resembled the plan conceived in June.[6] The heart of the reactor would be a twenty-foot cube of graphite weighing 460 tons. In the graphite would be 376 vertical columns, each containing twenty-two uranium-graphite cartridges. To remove the specified 100,000 kilowatts of heat, Moore and Leverett planned to pump 400,000 pounds of helium per hour through ducts into the bottom of the pile. The heated helium at the top would pass through heat exchangers requiring 900 gallons of water per minute. Until the experimental helium plant could be operated, these figures were tentative, but the engineers estimated they would need 12,000 kilowatts of electric power to operate the helium compressors and auxiliary equipment.

Moore and Leverett planned to surround the pile proper with several feet of graphite to act as an internal radiation shield. The entire assembly would be enclosed by a steel shell about twenty-eight feet in diameter and sixty-eight feet high. Following the advice of the Chicago Bridge & Iron Company, Moore and Leverett planned the shell as a series of spherical segments rather than a simple cylinder in order to provide greater structural strength. This configuration quickly inspired the nickname "Mae West pile." The upper section of the shell provided access to personnel loading the pile; the center section surrounded the pile itself; the lower section contained the dump mechanism which collected the irradiated cartridges. Actually, if the pile were ever constructed as planned, the shape of the shell would hardly be apparent since the entire assembly would be immersed in a huge cylindrical concrete tank filled with water.

Despite the activities of Moore and Leverett in developing their preliminary design, other scientists at the Metallurgical Laboratory were by no means satisfied. Early in July, 1942, Szilard and Wheeler expressed their growing concern that Compton had placed no equipment orders for the

helium-cooled plant. Since the large helium compressors would take many months to procure, Compton should place orders at once. So uncommitted was Compton to the helium pile that the two physicists were constrained to remind him of the June 25 decision, but they got little satisfaction. Apparently, Compton interpreted that action as a priority for the helium-cooled plant and not as an exclusive selection of the type for development.[7]

Szilard, always impatient with what he considered red tape or indecision, looked back in September on a summer of aimless drift. In a scorching memorandum entitled "What Is Wrong With Us?", he complained that no decision on the cooling system had yet been made and that none seemed forthcoming in the near future.[8] This unfortunate situation he attributed partly to Compton's desire to avoid controversy and partly to security restrictions imposed by the Army. The result was that Moore and Leverett had attempted to develop the helium pile without any clear directive or priority. Similarly, he said, Wheeler and Wigner had explored the possibilities of a water-cooled pile, while Szilard himself had struggled to assemble a research team to study the bismuth-cooled pile.

Those who knew the impetuous Szilard no doubt discounted some of his statements, but he had expressed a growing sense of frustration among his colleagues. Its origins lay not so much in the leadership or the scientists themselves as in the situation they faced. The design of a production pile involved so many complex factors that there was no hope of a quick and easy answer. In the final analysis, Fermi's observation still hit the main point: until the precise value of k was known, how could the engineers get down to the details of design?

Compton understood Fermi's argument and did not intend to decide prematurely. Back in June, 1942, Compton had seen the first plans for a water-cooled pile drafted by Wigner and Gale Young. Both were experienced physicists—Wigner, the leader of the nuclear physics group at Princeton until the project was centralized at Chicago; Young, a former member of Compton's own department who had returned to the Midway for the pile project. Impressed with their hastily prepared report, Compton asked them to complete within two weeks as much work as they could on plans for a 100,000-kilowatt water-cooled pile. The plan they delivered to Compton during July called for a graphite cylinder about twelve feet high and twenty-five feet in diameter. The uranium would be cast as long pipes and placed vertically in the graphite block. The pipes would suspend from a water tank above the pile, pass down through vertical holes in the graphite, and discharge into another water tank beneath the pile. The cooling water would circulate through heat exchangers and return to the top tank. To prevent corrosion of the uranium pipes, Wigner and Young contemplated spraying or coating the interior surface with some material like aluminum or beryllium which would absorb few neutrons. If this were not sufficient, they

proposed to line the pipes with aluminum tubing. After studying the proposal, Compton admitted that water cooling looked promising enough to justify further planning.[9]

Even more speculative but still too attractive to be disregarded were Szilard's investigations of a pile cooled by liquid metal. Several metals such as bismuth were known to have exceptional thermal properties. Szilard believed that a cooling system using bismuth would be so efficient that the size of the pile could be reduced substantially. He was also intrigued by the possibility that a bismuth pile could use the electromagnetic pump which he had developed in a preliminary way with Albert Einstein. Since the pump depended upon electromagnetic forces set up within the liquid metal, it would require no moving parts and would not be subject to leaks. The disadvantage was that such metals were distinctly exotic materials. Although their basic properties were known, they were not commonly used in power systems. There was enough novelty in a nuclear pile without adding the complications of employing unusual metals at high temperatures. For Szilard, the new and unusual held no cause for hesitation. Hoping to initiate experiments during the summer of 1942 as a part of the work of his Technological Division, Szilard began recruiting metallurgists and investigating sources of bismuth. The crisis in the procurement of uranium metal forced the postponement of most of this work. Deeply discouraged, by September, Szilard had little more than paper studies to show for his intentions.[10]

DECISION ON PILE DESIGN

In October, 1942, Conant and Groves began to push the scientists toward decisions in all parts of the S-1 project. While Conant took the S-1 Executive Committee on an inspection of isotope-separation projects in the East, Groves headed for Chicago to break the deadlock in the pile program.

Certainly, decisions were overdue at the Metallurgical Laboratory. Week after week, Compton had met with his Technical Council (as the Engineering Council was now called) and listened to hours of earnest discussion to no avail. True enough, the lack of a precise value for k beclouded the issue. Much more confusing, however, was the disagreement over the number and size of the steps to be taken from the exponential experiments to the production pile. In the spring of 1942, the council had proposed two big steps, one to a 100,000-kilowatt pilot plant and the second to the full-scale pile. More recently, Compton had requested designs for a 10,000-kilowatt unit. Moore and Wigner studied adaptations of their original helium- and water-cooled piles. Fermi analyzed a lattice arrangement of uranium lumps cast directly in the graphite blocks with occasional cooling pipes. Charles M. Cooper, recently arrived from the du Pont Company, explored the feasibility

with the laboratory at Chicago due for the greatest loss. Bush and Groves had asked the War Department to establish a committee on matters vital to the nation's safety. Compton admitted he did not see how this group could act quickly enough to relieve the immediate distress. On the other hand, he thought the Government would support nuclear research after the war. Until that time, the present policy would at least permit the University of Chicago to retain some key men at the Metallurgical Laboratory and to keep Argonne in operation. Walter H. Zinn and Warren C. Johnson asked how it would be possible to retain good men when the future seemed so nebulous. Franck inquired about the make-up of the advisory committee. Smyth wondered if the President would have a hand. He noted that Bush and Groves had taken the position that their authority was limited to the war. Yet they were the only channels through which scientists could approach the President. Compton argued for giving Bush and Groves a chance. If nothing happened, the scientists would be justified in going directly to someone with power to act.[35]

For almost a year, the restless scientists of the Metallurgical Project had been contending that the national interest demanded a continuing research effort. Though this was their main theme, a secondary strain was their concern with the international implications of atomic weapons. Compton himself had set the pitch in August, 1944, when he told the Project Council that the war would not be over "until there exists a firm international control over the production of nucleonic weapons." In early November, twenty-two of the most prominent scientists prevailed on Compton to forward a memorandum advocating that the United States issue a general statement on the new weapon in an effort to allay any suspicions that might exist among its allies. The Jeffries report with its call for international control was yet another manifestation of the sentiment that was current, particularly in the laboratories on the Midway.[36]

The secondary theme began to come through more clearly in February, 1945, after publication of the Yalta communiqué. Among the Chicago scientists sensitive to political issues, there was general agreement that the United States should take a strong position at the San Francisco conference to avert a secret race in nuclear arms. This was the time to capitalize on the nation's advantage and win what they considered the best guarantee of peace—a strong international research center with full access to the scientific activities of all nations.[37] Their concern reached the point of desperation in March when they judged the news from Washington to mean that Groves and the Military Policy Committee were taking a short-sighted view on even the research that the security of the nation required. Though there was talk in the capital about a committee to study future policy, this was vague and indefinite. Besides, the committee might be dominated by men who did not understand the imperatives of the hour. Not aware that Bush and Conant had been thinking and acting on international control, a growing number of scientists concluded that it was their duty to act.

No one was more inclined to take matters in his own hands than Leo Szilard. As early as September, 1942, he had suggested that the Metallurgical Laboratory give more attention to the political necessities bound to arise from its work. By January, 1944, he was so convinced of the necessity for international control that he wrote Bush and urged him to expedite the work on the bomb. Unless high-efficiency atomic weapons were actually used in the present war, he argued, the public would not comprehend their destructive power and would not pay the price of peace. Sometime in March, 1945, Szilard prepared a long memorandum explaining how vulnerability to atomic attack made it essential for the United States to seek international control. Presumably, the most favorable opportunity for presenting the matter to Soviet leaders would come immediately after the United States had demonstrated the potency of its atomic arm. In the interim, it was important to press American development. Scrambling his technology to cloak his reference to the hydrogen bomb, Szilard divided atomic development into two stages. The first was reaching fruition. If the United States were well along on the second when it approached Russia, the better the chances of success. If international control proved a vain hope, the worst possible course would be to delay developing the second stage. Mindful of his successful tactics in the summer of 1939, Szilard persuaded Einstein to write a letter of introduction to the President. Einstein did so on March 25, but this time nothing happened.[38]

While Szilard was pulling strings to gain a Presidential hearing, his more conventional colleagues were organizing seminars and speculating on the machinery of international control. When Roosevelt died, their hopes sank. Compton tried to find a vent for the desperation that gripped the laboratory. On the eve of the San Francisco conference, he took Franck to Washington to see his old friend Henry A. Wallace. They discussed the situation over the breakfast table, and on departing, Franck left behind a memorandum stating the views of the Chicago scientists. Its argument was that of the "Prospectus on Nucleonics" made more urgent by the events of March. Scientists, it warned, found themselves in an intolerable situation. Military restrictions were tearing them between loyalty to their oaths of secrecy and their consciences as men and citizens. Statesmen who did not realize that the atom had changed the world were laying futile plans for peace while scientists who knew the facts stood helplessly by.[39]

STIMSON BRIEFS THE NEW PRESIDENT

Unknown to the breakfast conferees at the Wardman Park, Stimson was preparing to brief President Truman on S-1.[40] On Monday, April 23, 1945, he had Groves and Harrison come to his office with a status report Groves had prepared. He spent most of Tuesday studying it. Late in the afternoon, Bundy joined him, and together they drafted a paper on the political significance of

possible during the next few months. He wanted to give his primary attention to atomic energy. Tuesday, he explored the use of the bomb with McCloy and Marshall. Wednesday, Memorial Day, he spent entirely in girding for the morrow's encounter with the scientists. During the morning, he restudied important papers and talked with Bundy, Harrison, Groves, and Marshall on how the bomb might be employed to effect Japanese surrender. After lunch, Stimson conferred again with Harrison, who had returned with a letter from O. C. Brewster, a Kellex Corporation engineer. Dated May 24 and addressed to the President with copies for the Secretaries of State and War, the letter had been forwarded through Manhattan District channels.

Aware of the bomb project through his work on the gaseous-diffusion plant, Brewster was as worried as any nuclear physicist about the dangers the nation faced. Other great powers would never permit the United States to enjoy a monopoly, he warned. Sooner or later, the inevitable race for atomic weapons would turn the world into a flaming inferno. Brewster proposed that American leaders announce that the United States had the bomb and would demonstrate its power. They should proclaim that the United States was foregoing its chance to dominate the world and propose arrangements for making sure that no nation could ever produce fissionable material in a form suitable for destructive purposes. Brewster saw no reason why materials already available should not be used against Japan, but he advocated halting further production as an evidence of good faith. Stimson considered this a remarkable document—so remarkable that he sent it to General Marshall with a note saying he was anxious for him to have the impress of Brewster's logic before the next day's meeting. He would take the President's copy to him personally or send it through Byrnes.[16]

Meanwhile, on May 25, Leo Szilard and Walter Bartky of the University of Chicago's Division of Physical Sciences called at the White House. They did not see the President, but Truman's secretary, Matthew J. Connelly, arranged a visit to Byrnes, who had returned to South Carolina for a few days. On May 28, Szilard and Bartky—joined by Harold C. Urey, ever eager for a cause—saw Byrnes at his home in Spartanburg. Szilard handed Byrnes the memorandum he had originally prepared for Roosevelt's attention. According to Szilard's memory in 1949, the question of using the bomb arose. Byrnes did not argue that it was necessary for the defeat of Japan; his concern was the Soviet Union. He thought American possession of the bomb would make Russia more manageable in eastern Europe. In Byrnes's recollection, the talk centered on Szilard's belief that he and other scientists should discuss atomic energy policy with the Cabinet. Whatever transpired, two attitudes emerged from the encounter. Byrnes acquired a distinctly unfavorable opinion of the physicist, while Szilard was convinced that Byrnes did not grasp the true significance of atomic energy.[17]

ton recognized that morale required a sense of personal participation. At a meeting of laboratory leaders on Saturday afternoon, June 2, he explained the Scientific Panel's interest in suggestions for the future of nuclear energy. He was leaving June 14 for a meeting of the panel and would appreciate having as much information as possible before his departure. To assure systematic treatment, it was decided to establish committees to explore clearly defined areas. Bartky would head a unit on organization; Zinn one on program; Mulliken a group on education, information, and security; Szilard one on production problems; and Franck a committee on social and political implications.[33]

The Chicago scientists responded to Compton's invitation with a will. During the next two weeks, the reports piled up—not only the formal committee presentations but the statements of individuals as well. One of the first to be finished was from the Committee on Political and Social Problems, submitted June 11 and signed by Franck and six colleagues: Hughes, Nickson, Rabinowitch, Seaborg, Stearns, and Szilard.

Stripped to essentials, their argument depended on two propositions. First, it was futile to try to avoid a nuclear arms race by throwing a cloak of secrecy over the basic scientific facts or by cornering the supply of raw materials. Second, when such a race developed, the United States would be at a disadvantage compared to nations whose population and industry were less centralized. The only hope for safety lay in international control. Since this was the case, it would be unwise to use nuclear bombs without warning against the Japanese. Such a course would cost the United States support throughout the world, precipitate a fatal competition, and prejudice the possibility of reaching an international agreement on control. A demonstration of the power of the bomb in some uninhabited area would create more favorable conditions for agreement. Besides, it would not preclude using the weapon later against Japan with the support of other nations. In any event, the decision should not be left to military tacticians alone. It involved national policy, a policy which had to be directed to achieving international control.

A sense of urgency ran powerfully through the Chicago laboratories that June. Fed by distrust for scientists turned administrators, it led some of the more impetuous spirits to prevail on Franck to take the report directly to Washington. They feared it might not work up through the Scientific Panel in time. Compton met Franck in the capital on June 12 and tried to arrange an appointment with Stimson. The Secretary of War was not available, but Compton saw Lieutenant Arneson of Harrison's office and gave him an unsigned copy of the report along with a letter to Stimson which explained he was submitting the document at the request of the Metallurgical Laboratory. The Scientific Panel had not yet considered it but would do so in a few days. Compton summarized the argument forcefully and succinctly—the scientists were proposing a technical as distinct from a military demonstration in the

successful test and the Potsdam Proclamation. Stimson was surprised to realize what a change Alamogordo had made in his own psychology. The result was changes that added "pep" (Stimson's word). The revision accomplished, emergency action was in order. Word had come in from Tinian that, weather permitting, the weapon would likely be used as early as August 1, Pacific Ocean time. Stimson therefore sent Truman a message asking authority to have the White House release the revised statement as soon as necessary. The next day, he dispatched Lieutenant Arneson to Berlin with two copies of the message. The President approved the draft just before he left the conference. Stimson also reviewed his own statement, but the revisions made in his absence did not offend him.[111]

Tuesday the thirty-first, Spaatz radioed that captured Japanese soldiers reported an allied prisoner-of-war camp one mile north of the center of Nagasaki. According to the same sources, which aerial photographs did not corroborate, Hiroshima was the only one of the four target cities that did not have camps containing allied prisoners. Did this intelligence influence the choice of objective for the initial strike? It was rather late for changes. General Handy replied that Spaatz's previous instructions still held. If, however, he considered his information reliable, Spaatz should give Hiroshima first priority among the four. On discretion, he might substitute Osaka, Amagasaki, and Omuta, but these were much less suitable. Should he decide on any one of them, Spaatz was to consult with General Farrell, Groves's representative on Tinian.[112]

On Wednesday, August 1, Groves brought a sheaf of papers to Stimson's office. Originating in the Metallurgical Project, they were but additional manifestations of the ferment at the University of Chicago. Leo Szilard had circulated a petition during the first two weeks of July. In final form it argued that a nation which set the precedent for using atomic bombs might have "to bear the responsibility of opening the door to an era of devastation on an unimaginable scale." If the United States should drop the bomb, it would so weaken its moral position that it would be difficult for Americans to lead in bringing the new forces of destruction under control. In view of this, the petition asked the President to forbid the use of atomic bombs unless the terms imposed on Japan had been made public and Japan had refused to surrender. Even in that event, it called on him to make the decision in the light of all the moral responsibilities involved.[113]

Sixty-nine of Szilard's colleagues had joined him in signing the petition, and Compton had forwarded it through channels to Washington. But the accompanying agitation inspired counterpetitions, and Compton had asked Farrington Daniels, the new director of the Metallurgical Laboratory, to poll his scientists in an effort to obtain a fair expression of opinion. Daniels announced the results to Compton on July 13. Fifteen per cent of the 150 who took part favored using atomic weapons in whatever manner would be most effective militarily in bringing prompt Japanese surrender at the minimum

Guéron, and another—Bertrand L. Goldschmidt—were French civil servants. Britain had promised Auger that he could leave the Tube Alloys work in May of 1944. As for Guéron and Goldschmidt, they had agreed to work in Montreal until August, 1944, at least, with the understanding that they could pay a short visit to France if this seemed desirable in connection with their scientific position in the French Government. Halban and Kowarski, who had brought Joliot's heavy water to England, had a special relationship. After prolonged negotiations, they had assigned their rights in past and future inventions to Britain. Halban further undertook to try to have the French Government assign Britain all rights in the patents it held. In return, Britain pledged herself to reassign to France all rights for metropolitan France and the French Empire in the Halban-Kowarski patents, in patents that the physicists might apply for on information which they brought with them from France, and in future patents they might obtain which were dominated by any of the others.

Sir John argued that the United States and Britain could not treat the French scientists as prisoners. Besides, whatever was done, the information eventually would reach Joliot and the French authorities. By virtue of the pioneering researches of her scientists and their help during the war, France had a better claim than any fourth country to participate in postwar arrangements. How far that claim should be recognized, if at all, was a matter for the signatories of the Quebec Agreement to decide at an apppropriate time. Meanwhile, it seemed unwise to take action which might give French officials a sense of grievance and lead them to raise their claims prematurely.

When Groves saw the *aide-mémoire,* he was astonished. He had never heard of these British obligations. Neither had Bush. In August, 1942, Anderson had written to Bush that Britain had acquired the rights of Halban and Kowarski and had taken steps to acquire the rights of other French inventors associated with them, but he had not indicated that Britain had agreed in return to extend certain rights to the French Government. The situation was awkward. At Quebec in 1943, Churchill had proposed and Roosevelt had agreed that neither partner should pass information to third parties without obtaining the consent of the other. Yet no one on the British side had taken that occasion to make clear the fact that prior obligations existed.

The issues raised by the Guéron episode had not been resolved when, early in November, Halban himself went to England. Groves understood from British representatives in America that their government would not allow the French physicist to go to the Continent. Yet as soon as Halban arrived in London, Sir John Anderson raised the question of his proceeding to France to talk with Joliot. The Chancellor did not approach the Combined Policy Committee, which was the arbiter of the interpretation and application of the Quebec Agreement. Instead, he turned to Ambassador Winant, with whom he had worked on the Congo ore negotiations. Anderson thought Halban should be permitted to visit his mentor, Joliot, for Halban needed to report on the

patent arrangements he had made. He could take advantage of the opportunity to persuade Joliot that France should not yet raise her claims on the future. To deny Halban a visit to France, the Chancellor argued, would threaten both security and the chance of acquiring the patent rights held by the government there. To make sure Halban did not pass an undue amount of information to Joliot, the British would furnish him written instructions on what to say, instructions setting forth in barest outline the progress made since 1940.

Anderson, a hard-driving negotiator, put pressure on Winant. Knowing Groves's opposition to the Halban visit, the Ambassador tried to persuade the General to come to London to talk with Sir John. But Groves could not break away, and Winant gave Anderson his assent. The Chancellor's contention that any different course would create an even more difficult situation convinced him, although it did not convince Groves. As he interpreted the Quebec Agreement, the disclosure of information required the consent of the President. Sir John, he believed firmly, had violated Churchill's pledge. He had sent to France information developed by American scientists with American money. Such were the fruits of interchange.[18]

Viewed in broad perspective, the French imbroglio argued the necessity of international control and the importance of prompt planning to that end. But coming when and as it did, it tended to divert attention from the central issue. Talking with Bundy on December 29, Stimson could see that the mess demanded Roosevelt's attention since it was more than a breach of military security. France was in a position to play power politics—to bring or threaten to bring Russia into the picture. All through Christmas week Stimson had sought an appointment with Roosevelt. Finally, about eleven o'clock on Saturday morning, December 30, General Watson called to say the President would see him in an hour. Stimson summoned Bundy and Groves at once and prepared to give his chief "the works on S-1."

A WHITE HOUSE LOOK AT THE FUTURE

When Stimson arrived at the White House, Groves at his side, the complaint that the British were allowing information to leak to the French dominated the conversation. Reminding Roosevelt of the Quebec Agreement pledge, Stimson accused Chancellor Anderson of hoodwinking "poor old John" Winant. Roosevelt listened to the story, fascinated. What were the French after, he wanted to know. Stimson did not profess exact knowledge but declared Sir John was putting them in a position to claim full partnership. Stimson had expected the President to take a dim view of this development. He was right. Roosevelt observed that the unstable political situation made France an unsuitable confederate at present. But even if her government were completely satisfactory, he saw no reason for cutting France into the atomic partnership.

Stimson now turned the President's attention to other issues. He told him that impending raw-materials negotiations as well as the French situation made it advisable to admit Secretary of State Stettinius to the little group of top officials who knew about the bomb. The President agreed. Stimson also pointed to the British vacancies on the Combined Policy Committee. Roosevelt suggested that Lord Halifax was the right sort of man for the post.

The President showed great interest throughout the interview, particularly in the implications of the leaks to France. Was Churchill in on all this? No, not so far as Stimson and Groves could tell. Anderson, a man dominated by the "imperial instinct," seemed to be running the show. Groves proudly defended his tactics in protecting information developed by American men, money, and effort. In response to Roosevelt's query, he said there was every evidence the Russians were spying on the bomb project, particularly at Berkeley.

Finally, Stimson showed the President a report Groves had prepared for Chief of Staff Marshall outlining current expectations on the availability of nuclear weapons. A gun-type bomb yielding the equivalent of a 10,000-ton TNT explosion and not requiring a full-scale test should be available about August 1, 1945. A second should be ready by the end of the year and others at somewhat shorter intervals thereafter. Scientific difficulties had dissipated previous hopes for an implosion bomb in the late spring. For weapons of this type, it would be necessary to use more material less efficiently than had been expected. Sometime in the latter part of July there would be sufficient metal for a unit with the effect of about 500 tons of TNT. It would be possible to produce several additional implosion weapons during the remainder of 1945. Their effectiveness should increase toward 1,000 tons each and, as some of the problems were overcome, to as much as 2,500 tons.

According to Groves, the plan of operations was based on the more powerful gun weapon with provision for employing the implosion type when it was ready. The target was Japan. Since nothing but the scientific difficulties themselves should be allowed to affect the time schedule adversely, the 509th Composite Group had been organized and put into training. The time had come to supply information to the Army, Air Force, and Navy officers whose co-operation was necessary in combat operations.

Roosevelt indicated that he approved the Groves report. By now, Stimson and Groves had stayed far beyond their allotted half-hour. But the President remained much interested, and when Stimson asked for another appointment, Roosevelt told him to call the next day at noon.[19]

The President was still in bed when Stimson saw him Sunday. Roosevelt reported he had already broached S-1 to Stettinius. Eventually, the conversation turned to the impending conference with Churchill and Stalin at Yalta. Russia was increasingly intransigent. Only the day before, Roosevelt had written Stalin to protest Russia's determination to recognize the Lublin Committee as the Provisional Government of Poland. Stimson took occasion

OWMR as liaison officer between OSRD and the White House and the enthusiasm with which he led the assault on the Magnuson and May-Johnson bills. A check with Newman's former boss, Secretary of the Treasury Fred Vinson, confirmed his appraisal. Vinson thought Newman possessed "a unique combination of talents" as an extremely able lawyer and a man of considerable scientific training.[20]

On the last week end in October, Newman left Washington to attend a conference in Rye, New York, sponsored by a group of social scientists and educators headed by Robert M. Hutchins and Robert Redfield of the University of Chicago.[21] Newman had been invited to attend because the purpose of the meeting was to organize opposition to the May-Johnson bill. When he arrived in New York City, he received a telegram from McMahon informing him that the special committee had been named and asking him to return at once to Washington. At breakfast at McMahon's home on Sunday morning, October 28, Newman found the senator facing the task with mixed emotions. He was tremendously pleased about his designation as chairman of the committee and terribly discouraged by the conservative bias of its membership. Newman agreed to serve as the committee's special counsel. In this position, he could give the committee the technical support it needed. He did not intend, however, to take over the usual administrative duties of an executive director. These would be given to Christopher T. Boland, a young lawyer McMahon had known for many years.

As Newman saw it, education should be the committee's first concern. How could the members hope to approach the questions of legislation intelligently unless they had some understanding of the nature of nuclear research and the problems peculiar to atomic energy? He believed that the committee members should first subject themselves to a period of self-education. Then, after a reasonable time, they could start hearings on the May-Johnson bill. There would be pressure from the War Department for immediate action, but Newman saw no need to hurry. Understanding the issues first was more important. More than a political body, the committee would be something approaching a seminar on science legislation. This emphasis would demand some expert talent to start the education process. Newman pondered the idea of establishing a panel of scientists or at least choosing one nuclear physicist to advise the committee on technical subjects.[22]

Over McMahon's name Newman sent letters to twenty-two scientists and educators asking for their recommendations. Many names were submitted, but high on the list was that of Edward U. Condon, who had just been selected to replace Lyman Briggs as director of the National Bureau of Standards. Newman had met Condon several weeks earlier, when Leo Szilard brought him to Newman's office. Szilard, in town for his appearances before the Kilgore and May committees, told Newman jokingly that he brought Condon with him because he had an honest, farm-boy face which reassured

those who were made uncomfortable by Szilard's Hungarian accent. Newman was aware of Condon's work at Los Alamos during the war, though he knew none of the details. He had been captivated by Condon's sparkling personality and good humor. On November 6, he announced Condon's appointment as the committee's scientific adviser.[23]

Meanwhile, Newman had not neglected his OWMR responsibilities. Not able himself to bear the full burden of drafting legislation, Newman turned to Thomas I. Emerson, the OWMR general counsel. Emerson suggested Byron S. Miller, a young lawyer who had worked in his office at OPA. With Government experience during the war, Miller had both the precision and knowledge necessary to capture Newman's torrent of ideas and subject them to the strictures of legislative terminology.

In the weeks following release of the May-Johnson bill, the two lawyers spent hours discussing atomic energy legislation. Miller made an exhaustive analysis of the bill, which Judge Rosenman sent to the War Department. They had incorporated many of their ideas in the memorandums which had helped to alert the President to the hazards of the War Department bill.

These projects made it easy for Newman and Miller to cast their broad principles in legislative form during the closing days of October, 1945. As an opening declaration of policy, they wrote: "The effect of the use of atomic energy for civilian purposes cannot now be determined. But it is reasonable to anticipate that tapping this new source of energy will cause profound changes in our present way of life." The nation must, they reasoned, develop atomic energy not only for military security but also to improve public welfare, raise the standard of living, and strengthen free competition in private enterprise. To do this, the commission would require the constant services of experts with a variety of talents. Thus, Newman and Miller provided for a nine-man, full-time commission whose members would be required to qualify in the range of disciplines set forth in the October 15 memorandum to the President. Furthermore, the commission would be closely tied to the Executive Branch by provisions that the commissioners and administrator be appointed by the President and be subject to his normal removal powers.[24]

Newman and Miller had a second principle—to give the new commission the responsibility and power to encourage and support atomic research. It was one thing to use the vaguely permissive language of the May-Johnson bill and quite another to spell out such powers in positive terms. If some kinds of research were to be free from commission control, the limits on commission authority would have to be sharply defined. This sort of definition relied on a sound understanding of nuclear research and production processes.

For this sort of technical assistance, Miller depended upon the atomic scientists. His best contacts were with Chicago, where he had taken his law degree before the war. In Washington he had kept in touch with

forced the Secretary to elaborate. In a second statement on December 15 he admitted that the order to MacArthur had gone over his name but without his knowledge. Taking the responsibility himself, Patterson did not reveal that Groves's office had issued the order on November 7. No matter, the damage was done. The scientists would not soon forget the incident. Months later, Herblock gleefully drew for the Washington *Post* a cartoon depicting a swarthy gladiator leaning back in his swivel chair to assure the nation that he could manage research while his hobnailed boots shattered delicate scientific instruments on the desk.[44]

If the Army could find any consolation in the events of December, it lay in the dismal fizzle of the Special Committee hearings. Armed with high hopes and a list of questions which Newman and Condon had carefully prepared, McMahon embarked on a series of leisurely hearings which consumed the better part of thirteen days between Thanksgiving and Christmas. The scientists were happy with the long-awaited opportunity to speak their minds, and the committee members were presumably broadening their knowledge of nuclear matters. But the rehash of facts which were sensational in August had no news value in December. Alexander Sachs, the first witness, set the tone for the hearings when he consumed a whole day for an excruciatingly verbose account of his part in enlisting Roosevelt's support in the S-1 project. Most of what followed was aimless, repetitious, and speculative. There was no controversy, few differences of opinion, and only an occasional barb. Perhaps McMahon was not yet sure enough of his committee to draw attention to the hearings by striking directly at the Army. To make matters worse, the Pearl Harbor inquiry just a few doors away was badly outdrawing him. Even the revelations of the December 7 tragedy had heavy competition in most newspapers from news of strike threats, housing shortages, and American troop demonstrations abroad. In a telegram, Simpson urged his Chicago colleagues to express their "deep concern that news commentators, newspapers, and the radio are not bringing to the American people an adequate report on the hearings."[45]

If McMahon was marking time, he was doing it with a purpose. Behind the scenes he was working with Newman, Miller, Levi, and Emerson on the third draft of an atomic energy bill. Miller and Levi were doing most of the legwork in reconciling the views of Newman and the scientists. McMahon himself had little interest in the details. What he wanted was a bill he could support before the committee and the Congress.

Two weeks before Christmas, Levi almost despaired of producing an acceptable bill. After several exchanges of draft with Miller, he still felt that some sections needed further revision. The scientists, especially Szilard, were becoming restless. Without Newman's personal support, Levi doubted that he could bring the scientists to accept the draft, but he knew they would not back the bill if the committee introduced it without consulting them. Somehow, in the swirl of events Newman, Miller, and Levi recon-

U. S. Atomic Energy Commission, Washington, D. C. A large portion of the OSRD documents are also to be found among the Records of the Manhattan District at Alexandria. In cases of duplication, the footnotes of this volume cite the OSRD collection.

OSRD-NA — Records of the Administrative Office, Office of Scientific Research and Development, National Archives and Records Service, Washington, D. C.

SAM — Records of the SAM Laboratories at Columbia University, Oak Ridge Operations Office, U. S. Atomic Energy Commission, Oak Ridge, Tennessee.

SCAE — Records of the Senate Special Committee on Atomic Energy, National Archives and Records Service, Washington, D. C.

CHAPTER 1

1. Minutes, Commission Meeting 18, Jan. 2, 1947, AEC.
2. James R. Newman and Byron S. Miller, *The Control of Atomic Energy, A Study of Its Social, Economic, and Political Implications* (New York, 1948), pp. 3–4.
3. *Time*, Dec. 30, 1946.

CHAPTER 2

1. Laura Fermi, *Atoms in the Family; My Life with Enrico Fermi* (Chicago, 1954), p. 154; Otto Hahn, "The Discovery of Fission," *Scientific American*, CXCVIII (Feb., 1958), 76–78, 80, 82, 84; Herbert L. Anderson *et al.*, "The Fission of Uranium," *Physical Review*, LV (Mar. 1, 1939), 511.
2. "Resonance in Uranium and Thorium Disintegrations and the Phenomenon of Nuclear Fission," LV, 418–19; C. L. Critchfield, Memorandum, July 6, 1946, FAS.
3. We have drawn freely upon the observations on the history of American physics made by Robert A. Millikan in his *Autobiography* (New York, 1950) and by Isidor I. Rabi in a talk at the New York meeting of the American Historical Association in December, 1957. Lawrence described the invention of the cyclotron in his Nobel Prize address, Dec. 11, 1951. *Les Prix Nobel en 1951* (Stockholm, 1952), pp. 127–34. See also Lawrence to W. Weaver, Feb. 24, 1940, LRL. Abelson reported his work in "Cleavage of the Uranium Nucleus," *Physical Review*, LV (Feb. 15, 1939), 418.
4. LV (Feb. 15, 1939), 416–18 (Mar. 1, 1939), 511–12.
5. *Physical Review*, LVI (Sept. 1, 1939), 426–50.
6. Dunning to A. O. Nier, Apr. 6, 1939, JRD.
7. H. L. Anderson, E. Fermi, and H. B. Hanstein, "Production of Neutrons in Uranium Bombarded by Neutrons," *Physical Review*, LV (Apr. 15, 1939), 797–98; L. Szilard and W. H. Zinn, "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium," *Physical Review*, LV (Apr. 15, 1939), 799–800. Professor Anderson graciously allowed us to read the manuscript of an edition of Fermi documents which he is preparing. His editorial comments are of great value in explaining the experimental work at Columbia. Hereafter this volume is referred to as the Anderson MS.
8. "Neutron Production and Absorption in Uranium," *Physical Review*, LVI (Aug. 1, 1939), 284–86; Szilard to Fermi, July 3, 8, 1939, OSRD.
9. Pegram to Hooper, Mar. 16, 1939, quoted in Fermi, *Atoms in the Family*, pp. 162–63; H. W. Graf, Memorandum for File, Mar. 17, 1939, OSRD.
10. Ross Gunn to Bowen, June 1, 1939, Bowen, Memorandum on Sub-Atomic

Power Sources for Submarine Propulsion, Nov. 13, 1939, OSRD.

11. Szilard to Joliot-Curie, Feb. 2, 1939, OSRD.
12. Copy enclosed as attachment, Alexander Sachs to authors, Sept. 29, 1959.
13. The Einstein letter of Aug. 2, 1939, the Szilard memorandum, and Sachs's covering letter of Oct. 11 are filed in FDR. Sachs has told his story most completely in a typescript manuscript, Early History Atomic Project in Relation to President Roosevelt, 1939–40, which is on file in MD. A somewhat abbreviated version was printed in Senate Special Committee on Atomic Energy, *Atomic Energy. Hearings on S. Res. 179,* Nov. 27, 1945—Feb. 15, 1946 (Washington, 1945–46), pp. 553–58. In his Sept. 29, 1959, letter to the authors he added some new facts and emphases and attached photostatic copies of pages from his diary for February, March, and April, 1939. Col. K. F. Adamson has recalled these events in a statement of Aug. 1, 1947, that is on file in Headquarters, U. S. Atomic Energy Commission. Szilard and Wigner tell somewhat different versions of the events leading up to the Einstein letter.
14. This account depends heavily on A. Hunter Dupree, *Science in the Federal Government; A History of Policies and Activities to 1940* (Cambridge, Massachusetts, 1957).
15. Watson to Einstein, Oct. 17, 1939, FDR; Watson to Briggs, Oct. 13, Szilard to Briggs with attached memorandum, Oct. 26, 1939, OSRD; *Hearings on S. Res. 179,* pp. 559–60.
16. Briggs, Adamson, and Hoover to Roosevelt, Nov. 1, 1939, Watson to Briggs, Nov. 17, 1939, Feb. 8, 1940, Briggs to Watson, Feb. 20, 1940, L. Dennison to Briggs, Feb. 21, 1940, OSRD.
17. Watson to Sachs, Feb. 8, 1940, AEC; Sachs to Watson, Feb. 15, 1940, in Early History Atomic Project, MD.
18. Einstein to Sachs, Mar. 7, 1940, Sachs to Roosevelt, Mar. 15, 1940, Watson to Sachs, Mar. 27, 1940, in Early History Atomic Project, MD.
19. Roosevelt to Sachs, Apr. 5, 1940, Watson to Sachs, Apr. 5, 1940, Watson to Briggs, Apr. 5, 1940, OSRD. In 1945, Sachs stated that he saw the President "at the end of March and early April." *Hearings on S. Res. 179,* p. 565. Roosevelt's letter of Apr. 5 contains no reference to such a meeting.
20. "Nuclear Fission of Separated Uranium Isotopes," *Physical Review,* LVII (Mar. 15, 1940), 546, and "Further Experiments on Fission of Separated Uranium Isotopes," (Apr. 15, 1940), 748. The role of 235 had been predicted by Bohr and Wheeler in the *Physical Review,* LVI (Sept. 1, 1939), 441.
21. Pegram to Briggs, Mar. 11, 1940, Briggs to Watson, Apr. 9, 1940, Gunn to Bowen, May 1, 1940, OSRD.
22. Szilard to Sachs, Apr. 14, 22, 1940, Briggs to Watson, May 9, 1940, OSRD.
23. Pegram to Briggs, May 6, 8, 14, 1940, OSRD.
24. Sachs to Roosevelt, May 11, 1940, Sachs to Watson, May 15, 1940, in Early History Atomic Project, MD; Sachs to Watson, May 23, 1940, OSRD.
25. Gunn to Bowen, May 1, 1940, Tuve, Notes on Atomic Power by Fission of Uranium 235, May 7, 1940, and Uranium Fission and the Separation of Isotopes, May 28, 1940, Bush to Briggs, May 28, 1940, OSRD; Urey to G. B. Kistiakowsky, June 7, 1940, AEC.
26. Briggs to Sachs, June 5, 1940, Briggs to Bush, July 1, 1940, OSRD.
27. Roosevelt to Bush, June 15, 1940, HLH; James P. Baxter, 3rd, *Scientists Against Time* (Boston, 1947), pp. 14–16; Irvin Stewart, *Organizing Scientific Research for War* (Boston, 1948), pp. 7–9; Robert E. Sherwood, *Roosevelt and Hopkins; An Intimate History* (New York, 1948), pp. 153–54.
28. Bush to Briggs, Sept. 19, 1940, Szilard to Joliot-Curie, Feb. 2, 1939, Pegram to Breit, May 27, 1940, OSRD.
29. Sachs to Briggs, June 3, 1940, Briggs to Sachs, June 5, 1940, OSRD.
30. Briggs to Bush, July 1, 1940, OSRD.
31. Bush to Briggs, July 9, 1940, Pegram, Memorandum, July 11, 1940, Pegram and Fermi, Memorandum Report on Proposed Experiments with Uranium, Aug. 14, 1940, Bush to Briggs, Sept. 7, 1940, OSRD.
32. Anderson MS; Anderson and Fermi, Production and Absorption of Slow Neutrons by Carbon, Sept. 25, 1940,

From
Joseph P. Lash
Eleanor & Franklin

fyingly. "The thing that upset me was the Town Hall debate in which he disputed the section of the President's message referring to the labor draft." Eleanor saw no perfidy in Carey's opposition to a labor draft. "Any official of the C.I.O. must be against a Universal Draft because his constituency is," she replied, "but that does not mean he is opposed to the President." When Browder, through Miss Adams, attacked the *Nation*, the *New Republic*, the *New Leader*, and "the special Trotskyite section of *PM* headed by Wechsler" for being unduly critical of the president, Eleanor defended Wechsler and the liberal weeklies. "He has a good mind and is honest," and the publications that Browder had criticized "make more sense to me than your confusing Trotskyite talk."

The president found Browder's all-out support helpful, but he was content to let the correspondence be handled by his wife. It was Browder's impression that the president felt more kindly toward him than Mrs. Roosevelt, although it was Mrs. Roosevelt who wrote the attorney general and the commissioner of immigration in 1944 when a deportation order was issued against Browder's Russian-born wife Irene. "I think she did so because the President asked her to," said Browder. "She was not sympathetic either to me or to my wife." The president, as Browder had correctly surmised, was a realistic politician, and whatever served the purposes of his policy he was prepared to use. Mrs. Roosevelt, the moralist, found it more difficult.

Just as Baruch, Hopkins, and Reuther all felt it was important to have Eleanor on their side in the conflict that was taking shape over reconversion policies, so the more socially minded nuclear scientists were coming to her with their anxieties about the uses of atomic energy. She had first learned about this most closely guarded secret of war in July, 1943, from a young physicist working on the A-bomb project. "He was convincing & rather frightening & we must have peace in the future" was her reaction to her meeting with the young man in a letter that she wrote afterward in which she did not indicate what it was that had frightened her.[32]

Scientist Irving S. Lowen was employed at the Metallurgical Laboratory, the Chicago phase of the Manhattan Project, which had among its workers Enrico Fermi, Leo Szilard, and Eugene Wigner. The last two had persuaded Einstein to send the letter to Roosevelt that led to the launching of the atomic project, and it was under Fermi's leadership that the first chain reaction had been achieved. The MetLab scientists were among the most creative at work in the Manhattan district and were also the ones most concerned with the political and social implications of this new force that they were freeing for man to use. In 1943 their anxiety centered on the fear that the Nazis might develop the bomb first. A message had reached them from a German scientist named Fritz Houtermans. "Hurry up—we're on the track" was the substance of his warning to his colleagues. The MetLab scientists felt that the military men in charge of the project thought of it as a weapon for the next war and did not grasp the need for speed. They were equally sure that the Army's bringing in of the duPont Corporation for the construction of the reactors at Oak Ridge and Hanford meant a nine-month "learning period" delay. The costly preparations that

duPont set about making seemed, the scientists felt, to betoken the corporation's interest in obtaining exclusive postwar control of this new energy source.

By the summer of 1943 they were sufficiently exercised over these matters (Arthur H. Compton, the director of MetLab, later wrote that he had had a "near rebellion" on his hands) to decide to go out of channels and try to reach the president directly—and Mrs. Roosevelt seemed the best way to do that. Lowen, an associate of Wigner's, thought he could get an introduction from an NYU colleague, Professor Clyde Eagleton, and volunteered to go to her not as a representative of the worried scientists, but on his own.

Eleanor saw Lowen at her Washington Square apartment in late July and immediately called the president to urge him to see the scientist. The president proposed that he talk with Dr. Vannevar Bush and Dr. James Conant, director and deputy director, respectively, of the Office of Scientific Research and Development. "Dearest Franklin," Eleanor wrote afterward, typing out the letter herself:

> Mr. Irving S. Lowen, the man whom I telephoned about will be in Washington tomorrow.
>
> Mr. Lowen says that Dr. Bush and Dr. Conant would be of absolutely no use because they have been so close to the project that they have perhaps lost the sense of urgency which these younger men have.
>
> There is they believe, a chance that a very brilliant man who is working on this in Germany may have been able to develop it to the point of usefulness. The Germans are desperate and would use this if they have it ready. It is imperative they feel that we proceed quickly to perfecting it and these young scientists believe that they are already two years behind all that they might have accomplished if they had been allowed to progress.
>
> They want an investigation by an impartial outsider who can see the possibilities of what might happen, but who is not a scientist, a man of judicial temperament who will weigh the possibilities.
>
> Mr. Lowen thinks you might want to speak to some of the other men
>
> Professor H. C. Urey, Columbia
> Professor Wigner
> Professor Szilard
> Professor Fermi
> Professor Oppenheimer
> Dr. Gale Young
> Professor A. H. Compton . . .[33]

"I hope you see Lowen. He impresses me with his own anxiety," she added in longhand.

Roosevelt did see Lowen the next day and evidently the young man made an impression, for when the president talked about the bomb to James Byrnes that summer, he told Byrnes that he thought the Germans were ahead in the race to develop it. Roosevelt also instructed Lowen that if he wished to send him a personal message again, he should place it in a sealed envelope for the president's eyes only and send it to him via Grace Tully.

If the intention of this directive was to cut his wife out of the chain of

that in my opinion, based on intimate knowledge of this whole project, everything is going as well as humanly possible. I believe we are very fortunate in having in General Groves, the Director of the enterprise, a man of unusual capability and force. Criticisms like Mr. Lowen's are based on an incomplete view of the total picture on the one hand and on the other represent the inevitable emotional reactions of human beings involved in an enterprise of this sort.[35]

One consequence for Lowen was that he was transferred out of the project. "I seem to be pretty effectively stopped from doing any more fighting," he reported to Eleanor. If she wanted any more information, Lowen continued, Wigner, Szilard, and Fermi would be happy to come to Washington to supply it.[36]

In a memo to the president, Eleanor suggested that he might ask Dr. Conant to see Wigner, Szilard, and Fermi "to tell about their work which has such important implications for the future."

Roosevelt was getting a little impatient. "Dear Van," he wrote Dr. Bush, "This young man has bothered us twice before and I think Jim Conant has seen him twice. I fear, too, that he talks too much. Do you think we should refer the matter to Conant?" Five days later Bush reported back:

Conant had a long talk in Chicago with Fermi and Wigner, and tells me they are quite satisfied with the arrangements now in effect and do not share Lowen's views. I spent all day with Szilard yesterday. His criticism boils down to the feeling that his group have not been fully used. There has, of course, been a reluctance to introduce scientists of foreign origin to the full knowledge of a matter of potentially great military importance. There is also a matter of early patent applications which has its difficulties.

My conclusion is that there have been no more missteps and delays than ought to be anticipated on a matter of this novelty and complexity and that the organization is sound and in capable hands.[37]

Conant's report to the president was not wholly correct, according to Wigner: "By that time I felt it was too late for a change, but we certainly did not tell Conant we did not share Lowen's views." While reconciled to the arrangements with duPont, the MetLab men were more than ever concerned with long-range development and control of the atom. Eleanor saw Lowen again, three weeks after D day. "We now have the discovery, I'm told, which he feared Germany would have first but I gather no one wants to use it for its destructive power is so great that no one knows where it might stop." "Our fears were political," recalled Wigner. "They were fears about letting this destructive force loose upon the world."[38]

To the nuclear scientists, and to the country generally, Eleanor and Franklin were partners. In the 1944 presidential campaign those who viewed her as a "dangerous" woman counted this against Roosevelt, but to the New Deal wing of the Roosevelt coalition her presence at his side was a reassurance as to Roosevelt's purposes. The prospect of a fourth term gave Eleanor fewer problems than had the third: "I don't know what F. will decide but if he thinks he

There was a request from nuclear physicist Leo Szilard to see her. He had composed a memorandum on how to avoid a nuclear-arms race with Russia. "I was not certain that this memorandum would reach the president if I sent it 'through channels.' . . . I intended to transmit my memorandum through her—in a sealed envelope—to the President." He was informed Mrs. Roosevelt would see him on April 12.

She had told Margaret Fayerweather that she was quite willing to hand over all that she was doing to someone else, but that reflected her yearning to step out of the public spotlight, not a readiness for a career of idleness. This was made clear in a reaction she expressed after a long day of seeing petitioners: "I was wondering yesterday when I leave the White House what my value will be in any of these things & what people will still be around!"[20]

That was April 6. Soon she would discover that the tasks she discharged as ombudsman were self-imposed, rooted in her sense of duty and her need to be of service, not in her position as the wife of the president. The week end of April 8 she and Tommy went to Hyde Park to unpack cases and barrels of china and glass. "We ache from our unwonted exercise," she wrote her husband, "but we've had fun too! In May I'll finish the job." She had seen Franklin Jr.'s wife, Ethel: "I think she'd be very pleased if you asked her to come & bring Joe [Franklin III] to San Francisco." She did not feel sleepy, her letter went on, so she had written "James, Elliott, & Frankie, Elinor Morgenthau [who had had a heart attack in Florida], Rommie & Sisty." She asked to be remembered to Margaret Suckley and Laura Delano. "I'm so glad you are gaining, you sounded cheerful for the first time last night & I hope you'll weigh 170 pounds when you return. Devotedly, E.R." That was the last letter between them.

On the morning of April 12 Eleanor had her regular press conference. She was asked about San Francisco, and some of the questions seemed to assume that the power of decision lay in the hands of the United States alone. "We will have to get over the habit of saying what we as a single nation will do," Eleanor said, once again using her news conference as a school for the country. "When we say 'we' on international questions in the future, we will mean all the people who have an interest in the question. A United Nations organization is for the very purpose of making it possible that all the world's opinion will have a clearing place." Her luncheon guest that day was Nila Magidoff, a lecturer for Russian War Relief, whose excited crossbreeding of Slavic phrases with English was such a delight to listen to that Eleanor persuaded Anna to forsake her little Johnny at the Navy Hospital to come to lunch to meet her. Afterward she saw Malcolm Ross of the Fair Employment Practices Commission.

At three o'clock Charles Taussig, an adviser to the U. S. delegation to San Francisco, was ushered into her sitting room. He wanted her help in ascertaining the president's wishes on trusteeships. She would call the president, she said, and try to find out. At this point Tommy signaled her urgently to take the phone. It was Laura Delano calling from Warm Springs to say the president had fainted and had been carried to his bed. Eleanor asked a few questions

SUMNER, JAMES B.—*Continued*

had been working in the broad field of protein molecule investigation.)

In 1946 the scientist reported that he was directing graduate research in the purification of coenzyme I, lipoxidase, and saccharase. He is the author of about one hundred research articles, many of them published in the *Journal of Biological Chemistry* and *Archives of Chemistry*; of *Textbook of Biological Chemistry* (1927); and with George Fred Somers, *Chemistry and Methods of Enzymes* (1943) and *Laboratory Experiments in Biological Chemistry* (1944), the former the first work in the English language to present a general survey of all classes of enzymes. In 1937 the Swedish Chemical Society rewarded work he had done at Cornell with its Scheele gold medal. Sumner is a member of the American Society of Biological Chemists, the American Association for the Advancement of Science, the Society of Experimental Biology and Medicine, and the honor societies Sigma Xi and Phi Kappa Phi.

In politics Sumner is a Republican; in religion, a Unitarian. He has been married three times, to Bertha Louise Ricketts of Jackson, Mississippi (in 1915; divorced), to Agnes Paulina Lundkvist of Stockholm, Sweden (in 1931), and to Mary Morrison Beyer (in 1943). Roberta, Nathaniel, Prudence, James, and Frederick are the children of his first marriage; John is the child of his third marriage. The scientist is five feet nine inches tall, weighs 162 pounds, and has brown hair and blue eyes. He has traveled much in Canada and Europe, lists his favorite recreations as tennis, canoeing, shooting, and skiing, and his favorite composers as Beethoven and Brahms.

References

N Y Times p4 N 15 '46
American Men of Science (1944)
National Cyclopædia of American Biography Current vol G, 1943-46
Who's Who in America, 1946-47

SURLES, ALEXANDER D(AY) Aug. 14, 1886—Dec. 6, 1947 United States Army officer; Army public relations officer; entered service in the United States Army in 1911 as second lieutenant of Cavalry, served in the Philippines, and in France in World War I; rose to the rank of major general; received in 1939 a post with the Seventh Cavalry (mechanized cavalry) and afterward the command of the First Armored Regiment of light tanks, both at Fort Knox, Kentucky; was director of the War Department Bureau of Public Relations, from 1941 until September 1945, when he became Director of Information, of the Army's postwar reorganized information services, remaining until his death in this post. See *Current Biography* 1945 Yearbook.

Obituary

N Y Times p77 D 7 '47 por

SZILARD, LEO (sĭ'lärd) Feb. 11, 1898- Physicist

Address: b. c/o University of Chicago, Chicago, Ill.; h. 5816 Blackstone Ave., Chicago, Ill.

Prominent among the atomic bomb scientists who have attempted to guide the world to a new type of international thinking in an atomic age is Leo Szilard, nuclear physics pioneer who was one of the first to try to interest the United States Government in the production of an atomic bomb. During the war a member of the Metallurgical Laboratory of the atomic bomb project, he is now associated with the Institute of Nuclear Studies of the University of Chicago.

Leo Szilard, one of the three sons of Louis Szilard, a construction engineer, and Thekla (Vidor) Szilard, was born in Budapest, Hungary, on February 11, 1898. Even as a boy he was unwittingly preparing for his present role in the battle to prevent the misuse of atomic energy. One of the most profound and lasting influences on his life, he told a New York *Post* interviewer, was a book which he read at the age of ten, the famous Hungarian dramatic epic *The Tragedy of Man* by Imre Madách, which he now sees as applicable to the atomic era. "In that book," he told Oliver Pilat, "the devil shows Adam the history of mankind with the sun dying down. Only Eskimos are left and they worry chiefly because there are too many Eskimos and too few seals. The thought is that there remains a rather narrow margin of hope after you have made your prophecy and it is pessimistic. That is exactly the situation in regard to the atomic bomb. We must concentrate on that narrow margin of hope."

Young Szilard received his elementary and secondary education in Budapest and then enrolled at the Budapest Institute of Technology as a student of engineering, intending to enter his father's profession. He attended from the fall of 1916 to the fall of 1919, with, however, one year, 1917-18, given over to service in the Austrian army. Then, in February 1920 he became a student at the Technische Hochschule at Berlin-Charlottenburg, and it was during the year that he spent here that his principal interest gradually changed from engineering to theoretical physics. For this, he has said, the presence of Max Planck, Max von Laue, Albert Einstein '41, and other famous physicists and the general scientific atmosphere of Berlin were responsible. In 1922 Szilard received his Ph.D. from the University of Berlin, where he had been working toward his doctorate in theoretical physics since early 1921, and was appointed an assistant in the Institute of Theoretical Physics of the university, at that time directed by von Laue. This post he held until 1925, when he was made *Privatdozent*. During these years, and until the early thirties, he divided his time between theoretical and experimental research in thermodynamic statistics and problems of X-rays at both the university laboratories and the Kaiser Wilhelm Institute in Berlin-Dahlem, and was closely associated with von Laue and Einstein.

When Hitler came to power in March 1933, Szilard left the country for Vienna. Six weeks later he went to London, where he spent several months trying to make up his mind what to do, meanwhile working with organizations engaged in placing refugees from German universities. In the summer of 1934 he became a member of the staff of the physics department of the medical college of St. Bartholomew's Hospital in London, and it was here that he began his work in nuclear physics, pursuing lines of investigation opened up by the experiments of Enrico Fermi '45, James Chadwick '45, Frédéric Joliot-Curie '46, and others in induced and artificial radioactivity. Early in this work, together with T. A. Chalmers, a colleague at St. Bartholomew's, he evolved a new principle of isotopic separation of artificially radioactive elements, which he explained in *Nature* of September 22, 1934. In June 1935 he left St. Bartholomew's for the Clarendon Laboratory of Oxford University, where he continued his researches in nuclear physics until December 1937. Back in 1931 it had been his intention to emigrate to the United States, but after a short stay he had gone back to Germany to wind up his affairs there. An arrangement with the Clarendon Laboratory permitted him to spend six months of each year in the United States, and after Munich he decided not to return to England but to remain permanently.

A short three months after Szilard had made his decision, in January 1939 Lise Meitner '45 startled the scientific world by announcing that the unexpected appearance of the element barium in the 1938 Berlin uranium experiments (conducted by Otto Hahn, Fritz Strassmann, and herself at the end of the year) had been the result of the actual splitting of the atom. Immediately, scientists throughout the world set to work to check the discovery. Confirmation of fission had already been obtained when Szilard, having borrowed two thousand dollars and brought over from England specially constructed equipment for the purpose, performed the experiment which settled beyond a doubt that the emission of neutrons accompanied the release of energy from uranium. This he later described in the *Nation*: "On March 3, 1939, Dr. Walter Zinn and I, working on the seventh floor of the Pupin Building at Columbia University [where they were research guests], completed a single experiment to which we had been looking forward rather eagerly. Everything was ready, and all we had to do was to lean back, turn a switch, and watch the screen of a television tube. If flashes of light appeared on the screen, it would mean that neutrons were emitted in the fission of uranium, and that in turn would mean that the liberation of atomic energy was possible in our lifetime. We turned the switch, we saw the flashes, we watched them for about ten minutes—and then we switched everything off and went home. That night I knew that the world was headed for sorrow."

Because of the military significance of the results obtained, leading British and American scientists, heeding the behests of Szilard, Fermi, E. P. Wigner, Niels Bohr '45, and others in the

LEO SZILARD

United States, voluntarily agreed to stop further publication of atomic data. In France, however, Joliot-Curie misunderstood—and with the publication of his conclusions the atomic race was on. Therefore, in July 1939, after Fermi in March had failed to arouse more than a cursory interest in the matter from the Navy Department, Szilard, Wigner, and Albert Einstein decided to approach President Roosevelt '42. Although Einstein declined to act as emissary as the others wished, he agreed to write a supporting letter, and this, together with a detailed description of the work already done by Fermi and Szilard and another memorandum by Szilard in layman's language, was presented to the President on October 11 by the New York economist Alexander Sachs. The Advisory Committee on Uranium then appointed by Roosevelt met for the first time on October 21, with Szilard, Wigner, and other scientists present ex officio. The Szilard memorandums were used as the basis of discussion, but the conclusion reached was that the project was premature and could best still be left in the hands of the universities. Not until the summer of 1940, after repeated pleas from Sachs and Einstein, was the work reorganized under the National Defense Research Committee. Then, the first contract was let to Columbia University under the general leadership of George B. Pegram, with Szilard and Fermi in direct charge, and until the end of 1941, Szilard recalled, they suffered from an excess of official recognition.

A change came after British scientist Marcus L. Oliphant had visited the United States and freely criticized the project. Early in 1942 the Columbia group was transferred to the University of Chicago, where the "Metallurgical Laboratory" was established under the general direction of Arthur Holly Compton '40 and researches in the manufacture of plutonium were begun and carried out. It was here that on De-

SZILARD, LEO—*Continued*

cember 2, 1942, the first chain reaction was obtained from the first plutonium "pile"—"a huge spherical lattice of graphite bricks in which small lumps of the natural uranium mixture . . . [were] imbedded at regular intervals," as proposed jointly by Fermi and Szilard—erected on the squash court beneath the university's athletic stadium. (This is described in detail by William L. Laurence '45 in the New York *Times Magazine* of December 1, 1946.) Shortly afterward (construction on production units, after the summer of 1942 organized under the "Manhattan Engineering District" of the War Department, having been undertaken simultaneously with the experimental work in Chicago), Fermi was transferred to Los Alamos as chief of the advanced physics department of the bomb production laboratory headed by J. Robert Oppenheimer '45. Szilard remained with the Metallurgical Laboratory in Chicago, which now concentrated on the problem of devising a commercially feasible method of extracting the plutonium produced by bombarding uranium with neutrons.

For much of the time Szilard and many of his colleagues had been afraid that Germany was ahead in the race to the atomic bomb. The realization of their purpose early in 1945 changed their fears from what Germany might do to the United States to what the United States might do to other countries. Discussions on this subject began in Chicago in March 1945, among about sixty scientists, and were only intensified by the dropping of the bombs on Hiroshima and Nagasaki in August. But through September, erroneously believing that negotiations concerning the bomb were in progress among the Big Three, the scientists expressed no opinions on its political implications. Early in October, however, on a visit to Washington Szilard secured a copy of the May '41-Johnson '46 bill for the drastic control of atomic energy, and this, together with newspaper reports that the bill had received only one hearing in committee, spurred them into action. The group at Chicago united as the Atomic Scientists of Chicago and began a campaign against the measure by issuing a manifesto calling for adequate Congressional hearings on the question. With groups from the other bomb installations, they formed first the Federation of Atomic Scientists and then the Federation of American Scientists, which has as its purpose educational work on the application of science to the national welfare and the influencing of legislation. Szilard was among the leaders of each movement and a spokesman in Washington.

On the whole, the scientists advocated sharing the atomic "secrets," because they could not in any case be kept hidden long and made the United States feared by other countries; recommended civilian rather than military, international rather than national, control; and vigorously opposed the proposed restrictions on free scientific research. Regarding the last mentioned, Szilard testified before the House Military Affairs Committee on October 18, 1945, that scientists at Chicago had found it necessary to break security regulations in order to proceed with their work and the United States would have had the bomb eighteen months sooner if these restrictions had not interfered. In May 1946, when they found that their views were making no impression in Congress, nine of the scientists, including Szilard, Hans A. Bethe '40, Edward U. Condon '46, and Harold C. Urey '41, and led by Albert Einstein, formed the Emergency Committee of Atomic Scientists to help arouse the world to the fact that "the unleashed power of the atom" threatened "unparalleled catastrophe" unless mankind learned to think on an international level. Their first campaign was for two hundred thousand dollars. In November 1946, after the atomic energy control bill which permitted the Army and Navy to make atomic weapons with Presidential approval and provided the death penalty for serious violation of security regulations had been enacted into law, they inaugurated a second campaign for one million dollars to carry on their work. As reported by the newspapers and stated in special magazine articles by the scientists, they believe that only a supranational government, sincerely entered into by all nations and with powers adequate to maintain peace as well as to attack the causes of world friction on an economic and cultural level, can solve the problem of the atomic age; and that the lead in its creation must be taken by the United States.

Szilard caused a stir when he addressed an open letter (first published in a fall issue of the *Bulletin for Atomic Scientists*) to Russian Premier Stalin suggesting that he broadcast to the American people Russia's stand on atomic control, while President Truman similarly inform the Russian people on the stand of the United States. There was much press comment when the scientist, recalling an old Federal law prohibiting a private citizen from addressing, without permission, an official of a foreign government on a matter of controversy, requested that permission from the United States Attorney General. A letter from the State Department refused sanction for the proposed letter; the Department of Justice would not venture an opinion on the legality of it.

Szilard, who in 1947 is associated with the Institute of Nuclear Studies of the University of Chicago, was one of the seventeen contributors to *One World or None,* described by Lewis Gannett of the New York *Herald Tribune* as "an effort, by some of the greatest scientists of our scientific century, to awaken their country and ours, their world and ours, to the facts of life." Szilard became an American citizen in 1943. His hobby, if he has one, he says, is "baiting brass hats," in keeping with his opposition to military control of atomic energy. Standing five feet six inches and weighing 170 pounds, he says, "I am satisfied I could reduce if I wanted to eat less, but I have never put it to a test." Nevertheless, wrote Oliver Pilat in the New York *Post,* the brown-haired, brown-eyed scientist "is not the sort of man to travel to the other end of town to try a good restaurant. When working he can skip lunch and dinner, can even go without sleep."

References

N Y Post p7 N 24 '45 por
Nation 161:718-19 D 22 '45
Sat R Lit 30:7-8+ My 3 '47

TAGLIAVINI, FERRUCCIO (tä"lyä-vē'nē fär-rōōt'chō) Aug. 14, 1913- Opera singer

Address: b. c/o Columbia Concerts, Inc., 113 W. 57th St., New York 19

"A quantity of listeners limited only by the fire laws took Tagliavini to their hearts almost immediately, and he responded by charming their hearts away with the beauty of his voice and the artistry of his singing." In these words, Irving Kolodin, the New York *Sun* critic, described the January 1947 Metropolitan debut of the Italian tenor Ferruccio Tagliavini, who came to the United States heralded by a wave of spontaneous publicity after a public career of six years in Italy.

Ferruccio Tagliavini, son of Erasmo and Neviani (Barbara) Tagliavini, was born in the northern Italian manufacturing city of Reggio Emilia on August 14, 1913. Because his father was employed as overseer on an isolated estate situated between Reggio Emilia and Bologna, for his first twelve years young Ferruccio did not go to school but was tutored with the children of the manor house. Later sent to school in Reggio Emilia, he determined to become an electrical engineer—he is licensed in that profession—although his father was urging him toward music. That he was a musical youth had been evident from an early age when he began lessons on the violin and learned famous tenor arias by ear. In school, between the acts of operettas, during which he played in the orchestra, he would entertain with his singing, and at least once he stepped into a leading operetta role at the last moment. Also a favorite as a church chorister, he soon gained the nickname "il piccolo Caruso." But he consistently refused to consider taking vocal lessons.

When Tagliavini was in his early twenties, his father, still certain that operatic fame awaited the youth, managed to lure him to Parma, a few miles distant from Reggio Emilia, at a time when open competitions were in progress at the city's conservatory. There the elder Tagliavini dared his son to sing for the judges. Though untrained, his voice made such an impression that he was immediately offered a scholarship. He refused, however, to give up his position as an electrical engineer and could only be persuaded to take lessons in his spare time from Maestro Italo Brancucci. After a short time these were discontinued, and then any decision about his career was postponed by several years of compulsory military training. In 1938 Tagliavini entered the local contest leading to the important Florence May Festival competition and, singing "O Paradiso" from Meyerbeer's *L'Africaine* each time, he won the local, regional, and national events. This decided him, and he began a seven-month period of intensive study with the internationally known tenor Amadeo Bassi. On October 28, 1939, he made his debut, as Rodolfo in Puccini's *La Bohème* at the Teatro Communale in Florence.

In the following seasons in Florence, Tagliavini sang the leading tenor roles in such operas as Mascagni's *L'Amico Fritz*, Bellini's *La Sonnambula*, Massenet's *Manon* and *Werther*, and Donizetti's *L'Elisir d'Amore*. In 1940, during his first performance in Palermo, Sicily—in *L'Amico Fritz*—he met and fell in love with Pia Tassinari, the soprano singing opposite him as Suzel. (They were married on April 30, 1941.) Francesco Cilèa, accepting his criticism of the action of *L'Arlesiana* as too hurried at one point, added pages of music and text to the opera. In a few years Tagliavini became an artist of recognized stature at the San Carlo Theatre in Naples, the Royal Opera in Rome, La Scala of Milan, and a favorite throughout Italy. He also became a film star during these years, making, in all, five films, including *Voglio Vivere Cosi, No Tanta Voglia di Cantare, The King's Jester,* based on Verdi's *Rigoletto*, and the *Barber of Seville*. The last-mentioned, an uncut version of the opera as presented on the operatic stage except for the use of deeper settings and close-up shots, was made, at Tagliavini's own suggestion, in order to bring opera to the potential audiences in the towns and villages which rarely saw a performance.

When the Allies took over in Italy, Tagliavini toured army camps, and American GI's brought back to New York enthusiastic reports of their newest favorite. Interest in having the young tenor appear at the Metropolitan Opera was further stimulated by the first shipment of Cetra recordings to the United States in September 1946, discs which sold rapidly even at three times the price of domestic records. Tagliavini himself, meanwhile, had left Italy for summer engagements in Central and South America, twenty appearances which included *Tosca* at the Teatro Colon in Buenos Aires; *Werther* opposite his wife as Charlotte, *La Bohème* opposite Bidu Sayao '42, and *Tosca*, at the Teatro Municipale in Rio de Janeiro; *Lucia* and *Rigoletto* opposite Lily Pons '44, and *Tosca* opposite Stella Roman, at the Opera Nacional in Mexico City. The tenor's North American debut occurred in Chicago on October 2, 1946, as Rodolfo in *La Bohème*. Before making his Metropolitan debut as Rodolfo on January 10, 1947, he also sang in *Madama Butterfly* and *Tosca* with the Chicago Civic Opera Company.

Advance publicity brought out a record attendance for Tagliavini's first appearance in New York, a nonsubscription performance; many persons were turned away. Critics reported the noisiest demonstrations they had heard in many years and added that for the most part the applause was well merited. Wrote Robert A. Hague of *PM*: "He has a beautiful voice—a true lyric tenor, fresh and warm of timbre, effortlessly produced and always under control. It is not a big voice, but it carries perfectly without forcing; even his pianissimo (which he uses with ravishing effect) can be clearly heard. His style of singing is florid